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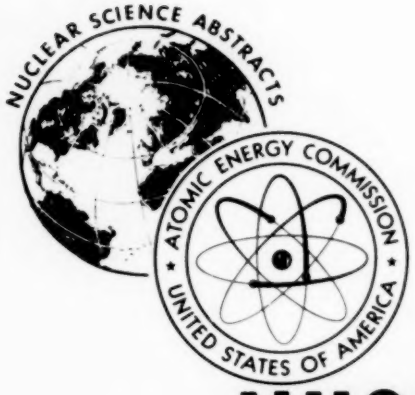

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NUCLEAR SCIENCE ABSTRACTS

Volume 17 Number 12

Abstracts 19720–21385

June 30, 1963

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Volume 17, Number 12, June 30, 1963

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NUCLEAR SCIENCE ABSTRACTS

GENERAL AND MISCELLANEOUS

19720 (ANL-6698) REACTOR DEVELOPMENT PROGRAM PROGRESS REPORT. (Argonne National Lab., Ill.). Feb. 1963. Contract W-31-109-eng-38. 75p.

Developmental activities are reported on Borax-V, EBR-I, EBR-II, FARET, general reactor technology, and advanced reactor research. Other work is reported on the Pu recycle program and nuclear safety. (J.R.D.)

19721 (BNL-759) NUCLEAR ENGINEERING DEPARTMENT PROGRESS REPORT, MAY 1–AUGUST 31, 1962. Jean H. Reynolds, ed. (Brookhaven National Lab., Upton, N. Y.). Contract [AT(30-2)-Gen-16]. 88p. (BNL-S-62)

The progress summary is presented in six sections. Separate abstracts were prepared for each section. (J.R.D.)

19722 (BNL-759(p.1-13)) REACTOR PHYSICS DIVISION. J. Chernick and H. Kouts (Brookhaven National Lab., Upton, N. Y.).

During this period, research was continued in fields such as the analysis of reactor systems, reactor kinetics, resonance physics, and thermalization in both homogeneous and lattice systems. In the analysis of specific reactor systems, attention was paid to Pu-fueled thermal reactors with high conversion ratios, to near-homogeneous graphite moderated critical assemblies, and to undermoderated D_2O reactors. In reactor kinetics, a study of the effect of "dead-band" control upon Xe oscillations was pursued. In microscopic reactor physics, progress is reported in the correlation of theory and experiment in the resonance absorption of neutrons and in the analysis of fission cross section data. In neutron thermalization, improvements were made in the understanding of water lattice data and in the relations of lattice temperature coefficients with cross sections. In addition, two general methods in thermalization–the polynomial method, and the method of separated kernels are being studied actively. Most of the work undertaken during the report period was concerned with two particular problems encountered in the analysis of the BNL metal-water lattices. The first of these problems arises from ambiguities in the definition of reflector savings for the small exponential assemblies used in the measurements. A theoretical analysis appears to account for the behavior of the experimental results. A small discrepancy remains, however, between theory and measurement. In an effort to resolve this difference, work was started on a more detailed treatment of the thermal spectrum at the core-reflector interface. The other principal area of study was the thermal neutron distribution in lattice cells; particular emphasis was placed on the influence of cylindrical cell boundary conditions on the flux distribution and the effect of anisotropic scattering in the moderator. Measurements in clean and poisoned lattices with nominal water-to-oxide volume ratios of 1.5:1, 2:1, and 3:1 were completed. Miniature lattice measurements of the thermal fine flux distribution with Dy foils were improved. Since the first U-graphite assembly was brought critical, a series of safety measurements was made. A gamma survey of the Critical Facility Complex (Bldgs. 526, 526A, and 526B) was taken at various power levels of the High Flux Beam Reactor Critical Assembly. The feasibility of comparing U^{235} content by the pulsed neutron-delayed neutron method was demonstrated. Fe filter measurements, performed on the Cold Neutron Project, gave a value of the width of resolution function which compared with that expected from calculations based on previous measurements. The major areas of investigation for the Fast Settled Bed Reactor included bed hydraulics and carbide fuel development. More refined experimental equipment was designed for the hydraulic studies. An attempt was made to define more thoroughly the bed characteristics for physics evaluation of the fast reactor system. Additional shipments of UC were received and evaluation of these fields was initiated. The in-pile capsule experiments were approved by the Reactor and Critical Experiments Safety Committee. A survey of government, university, and private laboratories was made to determine the need and interest in a chemonuclear test reactor. It was concluded that the major interest lies within the BNL program and with other government-sponsored programs. The reference design for a chemonuclear reactor to produce CO was chosen. This concept will be externally moderated, CO_2-cooled, and will have a chemical output of 1220 tons of CO/day. The electrical output will be 170 Mw(e). The programming of THORCYC, a one-dimensional multigroup diffusion theory, fuel cycle analysis code, was continued and 35 subroutines were completed. Reference runs are continuing in the Organic Reactor Coolant fouling studies to determine the effect of bulk and surface temperatures, using pure p-terphenyl in static SS capsules. A very thin, tightly adhering film of $Fe_{21}C_9$ (by x-ray diffraction) was found for three different test conditions (but at surface temperatures above 400°C in each case). No measurable transfer of Fe (as Fe^{59}) occurred in pure p-terphenyl between 360 and 450°C in a preliminary test run. Concentrations in the terphenyl of 68 ppm H_2O and up to ~85% pyrolytic decomposition products had no effect. However, at this latter concentration (and very high coolant viscosity)

tracer Fe was found in the coolant immediately adjacent to the immersed Fe sample. The first set of four type 304 SS tilting-furnace capsules was prepared for mass transfer tests. The axial-flow pump was calibrated with water and the other loop components fabricated. Studies of the stability of selected condensed aromatic compounds to heat, Co^{60} gamma radiation, and reactor radiation are continuing. Electric generating methods as alternatives to the SNAP turbogenerators are being investigated. These generators would be reactors having a minimum of moving parts and high reliability. Theoretical investigations of the Pulsed Fission Plasma Reactor indicate a possible overall conversion efficiency of 55%. Experiments will be performed to check stability and efficiency. A thermally regenerated fuel cell utilizing a lead, lead bromide, bromine system was selected for experiment. The Neutron Cross Section Compilation Group has nearly completed a revision of the compilation of angular distributions (BNL-400). (auth)

19723 (BNL-759(p.14-38)) CHEMISTRY AND CHEMICAL ENGINEERING DIVISION. (Brookhaven National Lab., Upton, N. Y.).

A cell was designed and constructed for the measurement of the free energy of formation of ThF_4 at high temperatures. The first run yielded a value of –431.2 kcal at 520°C. A subhalide was found in Mg–$MgCl_2$ systems. Its concentration as a function of Mg activity was determined by a chronopotentiometric method. Results indicate that the lower-valent Mg ion has the form Mg_2^{2+}. The subhalide formed in small quantity when $PbCl_2$ is equilibrated with Pb absorbs strongly in the visible. Measurements of the spectrum were obtained at 530°C. In the fluorocarbon program, electron irradiations were carried out on hexafluorobenzene from a new commercial source, and on perfluoro octane, C_8F_{18}. The hexafluorobenzene results agreed with those obtained earlier on material of about the same purity ($G_{-C_6F_6} = 2.5$) and the C_8F_{18} behaved about like the previously run C_7F_{10} ($G_{-C_8F_{18}} = 2.2$). The synthesis of perfluoroterphenyl was attempted with a variety of reaction sequences, using derivatives of C_6F_6 as starting material. Only mixtures hard to resolve have been obtained so far. The reversible adsorption of I_2 at 800°C on a new sample of TSX graphite containing no previous residue of I_2 was found to be $\frac{1}{5}$ that (10 ppm) previously observed on similar graphite containing about 200 ppm residual I_2. The presence or absence on the same graphite sample of the residual I_2 had little or no effect on the adsorption of I_2 on graphite at 100°C over the range of 10^{-4} to 0.30 fraction of the saturation pressure; this indicates that the residue does not appreciably alter the surface area or the heat of absorption. The residual I_2 is the only form of I_2 found present to an appreciable extent on TSX graphite at temperatures above 500°C; it was not formed at temperatures above 100°C and at I_2 pressures below 30 mm. The specific surface area of TSX graphite is markedly increased by subdividing or grinding; the increase can be accounted for by assuming an exterior surface roughness factor $>10^2$. Further measurements with a Re-graphite thermocouple for high temperature measurements in a C atmosphere show this thermocouple to be reproducible to within about 15°C at 750 to 2200°C; embrittlement at the junction is still an important problem. Bench-scale experiments designed to study the continuous production of phosphate glass from simulated Purex waste show that Pt is a suitable corrosion resistant material for construction of the high temperature crucible. Other experiments indicate that the off-gases from the glass-forming crucible may be treated by condensation and then distillation. Development of a rotary calciner for the treatment of high activity Al wastes is now concerned with perfection of the equipment in preparation for a 1000-hr run to be made later this year. Particular emphasis is placed on the improvement of the rotary seal and the solution feeder nozzle. The longest run to date (over 70 hr) was completed successfully. Difficulties encountered in the fabrication of a ceramic-lined reaction vessel for the decladding of SS with Cl_2 gas led to the exploration of the possibility of carrying out the reaction in a static alundum bed where the walls of the reactor are protected from the high heat of reaction by the insulating properties of the bed. Preliminary results are encouraging. Investigation of the effects of high-temperature Cl_2 on UO_2 was also begun. The modified Nitrofluor Process solvent-reagent, NOF · 3 HF, continues to show advantages over the original NO_2–HF mixture for all fuel materials except those with a graphite matrix. Progress was made toward a more rapid production method, in which liquid, rather than gaseous, NOCl is added to liquid HF. The variables in this production reaction and in the subsequent fractionation process were studied experimentally in order to optimize the yield of the NOF · 3 HF fraction. Dissolution rates of UO_2 in this reagent obtained under various conditions showed that it is desirable to use a large excess of liquid, in which the $NOUF_6$ reaction product is wholly soluble. Analysis of the gases produced in the dissolution of UO_2 has shown them to consist of NO and NO_2, provided an excess of solvent is present. Cooling curves were obtained on a series of compositions in the system NOF–HF, in order to obtain the liquidus lines. Maxima in the freezing point vs composition diagram were found at points corresponding to the compounds NOF · 4 HF, NOF · 3 HF, 2 NOF · 5 HF, 3 NOF · 5 HF, and NOF · HF. The system is complicated by the occurrence, in two separate composition regions, of pairs of immiscible liquids. Fractionation of a liquid with the approximate composition NOF + 7 HF yields HF and two major liquid fractions, one boiling at 68°C (NOF · 6 HF) and one at 95°C (NOF · 3.1 HF). Addition of small amounts of water to the starting material caused large changes in the relative amounts of product, the 68°C fraction increasing at the expense of the 95°C fraction. The dissolution of UO_2 in NO_2–HF was tested on a bench scale, 72 g UO_2 being dissolved. The resulting solution was transferred, in eight portions, to an evaporator where excess solvent was removed and UF_4 recovered. The dissolver vessel was barely corroded but the evaporator was noticeably attacked. A possible solution to this difficulty is to line the evaporator with Pt. The volatility of $NOUF_6$ in NOF atmospheres at 390 to 500°C was used to obtain quantitative transfer of U from the hot region to a cooler zone, at 350°C. The condensate was UF_4. U transfer was also obtained when the starting material was UF_4, UO_2F_2, or UO_2; and when it was the mixture of fluorides resulting from the dissolution of STR-type fuel in NOF · 3 HF. An attempt to volatilize U out of a solution of $NOUF_6$ in NOF · 3 HF by treatment with elemental fluorine proved unsuccessful. An investigation of the chemical and physical behavior of fission products released into a He stream from irradiated molten U–Mo fuel samples shows that the I_2 released deposited in some combined form and not as elemental I. Temperature was the only variable found to affect the fission product deposition zone and it is concluded that the I and Ba–La release was not particulate under these experimental conditions. Ce and Ba–La deposited at 1025 to 1175°C and 1100 to 1200°C respectively. Thermodynamic considerations indicate that increased fuel burn-up would not alter the I_2

deposition behavior. In a study of fused salt-liquid metal extractions in a disc-and-doughnut column, estimates of overall mass transfer coefficients based on the salt decreased from 260 to 6 lb Ce/[(hr)(ft^2)(lb Ce/lb salt)] as the equilibrium salt : metal concentration ratio increased from 7 to 600. After several months of de-bugging the test section of the NaK heat transfer loop, it now appears that good, reproducible data can be obtained on it. In this study, heat transfer coefficients are being measured on the central rod of a 19-rod unbaffled rod bundle for in-line, turbulent flow. The trouble has been that the local coefficients around the circumference of the rod varied when the rod was rotated, indicating the requirement of symmetry had not been met. In an analytical study of heat transfer to liquid metals flowing in an eccentric annulus, heat transfer coefficients, as a function of angle, were obtained for eccentricities of 30 and 70% at Peclet numbers 367, 1700, and 8000. They were obtained under the conditions of $r_2/r_1 = 1.50$, constant heat flux, and fully established flow. A short study was carried out to obtain a solution for the temperature distribution in a fluid flowing in an eccentric annulus with a slug-flow velocity profile. This would enable one to arrive at an approximate Nusselt number for the case of liquid metals flowing through such a channel under conditions of fully-established turbulent flow. To give an indication of the eccentricity effect, when the eccentricity is increased from 0 to 50%, the slug-flow Nusselt number decreases 33%. The decrease in the actual heat transfer coefficient would always be less than this, but would approach it at low flow rates. In another study, the effect of rod misalignment in slug-flow heat transfer in rod bundles was determined. A solution was obtained for a triangular array with one rod displaced in a direction normal to the line of centers of two adjacent rods. To give an indication of the effect, a displacement 50% of maximum would reduce the slug-flow Nusselt number for the rod by 29%. This would correspond to a reduction in the actual heat transfer coefficient of about 20% at a Peclet number of 1000. (auth)

19724 (BNL-759(p.39-46)) RADIATION DIVISION. B. Manowitz (Brookhaven National Lab., Upton, N. Y.).

Studies are continuing on the effects of radiation in organic solids, the mechanism of radiation-induced vinyl polymerization, and the mechanism of radiolysis in aromatic compounds. Improvements were made in the high temperature measurement apparatus, and x-ray diffraction measurements of the thermal expansion of Re and ThO_2 have been completed. An in-pile chemonuclear loop is being designed, in-pile capsule experiments are being carried out, chemonuclear fuel is under development, radiation chemistry experiments with isotopes are under way, and chemonuclear reactor process systems are being investigated. Studies of radiation-induced polymerization of ethylene at high pressures, and copolymerization of ethylene with various monomers were continued. Other investigations are in progress on the formation of UC, radiolysis of anhydrous and aqueous ammonia, and decomposition of organometallic compounds. A feasibility study of a high pressure gamma loop facility was completed. The High Intensity Radiation Laboratory building was completed and installation of cell equipment is proceeding. Feasibility studies of portable Co^{60} and accelerator irradiation facilities were completed. A Research Food Irradiator was installed at the University of Washington and preparations are being completed for staffing the AEC Atoms at Work Exhibits in Chile and Thailand. Experimental studies of heat build-up in high level source arrays, dose distribution in various target-sourced geometries, and radiation damage to shielding glass are continuing. Dosimetry studies on the Fricke dosimeter were made and development of solar cell dosimeters continued. Corrosion studies on the Sulfex and Zirflex processes were completed and experiments are continuing on the dissolution of 347 SS-clad elements in 309 SCb SS containers. Studies are continuing on the removal of long-lived nuclides from waste streams by ion association complexing. (auth)

19725 (BNL-759(p.47-53)) HOT LABORATORY DIVISION. L. G. Stang, Jr. (Brookhaven National Lab., Upton, N. Y.).

Work performed this period in the area of isotopes development is summarized. The problem of iodinating protein with I^{124} was solved successfully and yields of ≥50% can now be expected routinely. Observed nonuniformity of thin deposits of Li^6F may render too difficult the interpretation of results which might be obtained from an attempt to determine the low end of the $Mg^{26}(t,p)Mg^{28}$ excitation function via reactor irradiation. The half-life of Mg^{28} was measured to be 20.88 ± 0.06 hr. Allowing fast neutrons from a natural Li target bombarded with 20-Mev deuterons to strike a quartz target yielded 300 μμC of carrier-free Mg^{28} per μah of deuterons. The computer was used to calculate evaporation probabilities from several compound nuclei and hence excitation functions for particular reactions of interest. A seventeenth degree polynomial was found which describes the gamma spectrum of Mn^{54}. Two "milking" systems, each apparently satisfactory, were found for separating 2.8-hr Sr^{87m} from its 80-hr Y^{87} parent. Preliminary measurements in hole PN-3 in the BGRR indicate $\sigma_r/\sigma_f = -0.0042\ E_{eff} + 0.049$, in the region 4.3 Mev < E_{eff} < 9.8 Mev, where σ_r is the cross section for reactor neutrons and σ_f is the cross section for unmoderated fission neutrons. Research and development work in the area of radiochemical analysis includes the extraction of U by tri-n-octylamine (TnOA) from a HCl medium in the absence of TTA. This reaction can be described by $UO_2^{2+} + 2\ TnOA \cdot HCl \rightleftharpoons UO_2Cl_2\ (TnOA \cdot HCl)_2$. When TnOA and TTA are both present, evidence has been found for direct bonding between TnOA and Th, rather than between TnOA and TTA. Pulse-height spectrometry of charged particles arising from neutron interactions appears to be of use as a means of identification and determination of reacting nuclides; the thicknesses of thin films of Li^6F determined by this means using a solid state detector have been correlated with values obtained by flame photometry. The fact that, in molten KNO_3-LiNO_3 eutectic, Pb^{2+} and Cd^{2+} produce nearly identical half-wave potentials at the dropping Hg electrode whereas in conventional aqueous media the half-wave potentials are separated by as much as 0.20 v has been explained by evidence which points to the greater tendency of Pb^{2+} than of Cd^{2+} to form nitrate complexes in concentrated nitrate media. Current-reversal chronopotentiometry studies are being made on Zr–Bi alloy and on Zn dissolved in a molten Bi pool, both in the LiCl–KCl eutectic. In the area of isotope production several new customers were added and several foreign shipments were made. The net change in "D" waste inventory was an increase of over 24,000 gal due partly to resumption of operation of the deionizer in the BGRR canal circulation system but also to contamination of two tanks of "F" waste and to a leaky valve which admitted fresh water to the waste system. (auth)

19726 (BNL-759(p.54-77)) METALLURGY DIVISION. D. H. Gurinsky (Brookhaven National Lab., Upton, N. Y.).

In boiling Hg loops without inhibitors corrosion penetration of steels is comparable to that in similar loop experiments in which Ti or Zr inhibitors were used. With 1100°F boiling and condensing, the maximum penetration in 5000 hr was <1 mil. Surface deposits of ZrN or TiN were identified by electron diffraction of films stripped from SAE 1020 or ASTM A-106 steel after the steels were contacted with Hg containing Zr or Ti at 1100 to 1200°F. The effectiveness of pretreating the steel with liquid Hg containing inhibitors before starting the boiling tests is being investigated. Nb-1 Zr reflux capsules containing Na boiling at 2200°F showed no radiographically detectable corrosion after nearly 5000 hr of operation; detailed examination is not yet complete. The suitability of Pt-Pt-10% Rh thermocouples at 2200°F in high vacuum is questionable; in all tests, the millivolt output dropped during the test and a loss of material from the Pt-10% Rh wire was observed. Chromel-Alumel thermocouples failed; W-Ir and W-W-26% Re appear to behave satisfactorily. The first Nb-1 Zr boiling loop ran for 610 hr at which time failure occurred in the Pt-Pt-10% Rh thermocouples. It was re-instrumented and will be started again during the next period. Fabrication of the first high velocity boiling Na loop was completed. A burn-up of 16% of the U^{235} was achieved on all types of HFBR fuel elements currently being tested at the NRTS. Electrodiffusion experiments for Cr in liquid Bi showed Cr migrates toward the anode under electrolysis. Quantitative data were obtained. The solubility of Fe in Hg was measured at 450 to 700°C; the new data are in general agreement with the published GE results. The relative damage to thin films caused by α particle and fission fragments is in agreement with the difference in total energy of the two types of particles. For exposures up to 2×10^{18} nvt, the net effect of C additives to pure Fe is to reduce the change in properties resulting from neutron bombardment. Metallic additions also have the same effect. No apparent differences in the dislocation structure in pure Fe foil was observed between irradiated and unirradiated specimens. A steady state chain mechanism for radiation effects in graphite is described which explains the contraction observed with frequent annealing of the stored energy. Removal of the smallest species in the chain by thermal annealing indirectly removes the largest species. Increasing the frequency of the annealing cycles with BGRR resulted in improved dimensional recovery. Increased frequency of annealing also decreases the effect of irradiation on the electrical properties of graphite. Under equivalent conditions, natural graphite powder was observed to absorb more Br than artificial graphite powder. Rate equations based on the assumption that a graphite-Br phase of fixed composition grows into the graphite at a constant linear rate are in general agreement with the data. The release of fission gases from irradiated UC powder at low temperatures appears to occur by a single "jump" rather than by a series of successive steps, as in normal diffusion. (auth)

19727 (BNL-759(p.78-80)) ENGINEERING DIVISION. T. V. Sheehan (Brookhaven National Lab., Upton, N. Y.).

Work on the HFBR building is progressing with the building shell nearing completion. The BNL staff assigned to this project is engaged in approvals and inspection of the contractor's work. In addition, the BNL group has the responsibility for the design and construction of various pieces of BNL-supplied equipment for the reactor and for the critical experiments. A preliminary design report of the Chemonuclear In-Pile Loop is being prepared for the Reactor and Critical Experiments Safety Committee. Design, construction, and test work is continuing on various other loops for heat transfer and corrosion studies. New control rods for the Low Mass Critical Experiment are now being fabricated. A fuel basket, shipping casks, and a protective cage were designed for the UO_2-ThO_2 Lattice Experiment. A shielded carrier for the Graphite Research Reactor is now being designed. The HIRDL building is essentially complete. The Engineering Division is presently reviewing drawings of various mechanical components. The University of Washington irradiator has been installed. The fabrication of sources to be irradiated at SRP should be completed during the next report period. All of the materials were ordered. Preliminary tests of the rotary seal for the Bartlett-Snow calciner indicated satisfactory results. A preliminary report for the Settled Bed Reactor in-pile capsule was presented to the Reactor and Critical Experiments Safety Committee and approval was granted. (auth)

19728 (NP-12716) SIXTH ANNUAL REPORT, 1961–62. (Japan. Atomic Energy Commission, Tokyo). 104p.

Progress in atomic energy development in Japan is reported. Topics covered include: organization, legislation, and budget; nuclear reactors; nuclear fuel; use of radiation; radioactivity countermeasures; regulation and protection; other research and development; international cooperation; and training of scientists and engineers. (M.C.G.)

19729 (PNE-204F) STRUCTURAL SURVEY OF PRIVATE MINING OPERATIONS. (Bureau of Mines, Oakland, Calif. and Nevada Operations Office, AEC). [1962]. Project SEDAN. 11p.

A survey of the pre-event and post-event physical condition of all existing privately owned mining properties that might sustain physical damage from the Sedan event is presented. (J.R.D.)

19730 (PNE-205F) FEDERAL AVIATION AGENCY AIRSPACE CLOSURE. Preliminary and Final Report. Stuart Halsey (Federal Aviation Agency. Air Route Traffic Control Center, Salt Lake City). 1962. Project SEDAN. 11p.

Measures to ensure airspace user safety during the Sedan event of Plowshare operation are described. (J.R.D.)

19731 (PNE-233F) TIMING AND FIRING. Ellery M. Matthews and Bernard F. Murphy (Edgerton, Germeshausen and Grier, Inc., Boston; Edgerton, Germeshausen and Grier, Inc., Las Vegas, Nev.; and Edgerton, Germeshausen and Grier, Inc., Santa Barbara, Calif.). Mar. 1963. PROJECT SEDAN. 12p. (EG&G-L-581)

A summary of timing and firing support furnished to participants of the Sedan event is presented. (J.R.D.)

19732 (TID-18458) VISUAL AND PHOTOGRAPHIC ON-SITE INSPECTION. Final Report. R. B. Hoy and R. M. Foose (Stanford Research Inst., Menlo Park, Calif.). June 1962. Project 7.5 [of] OPERATION PLOWSHARE—PROJECT GNOME. 46p.

On-site investigations were conducted for Gnome to assist in defining appropriate techniques and procedures to be used by an inspection team for identifying and locating clandestine nuclear events. The procedures used included aerial photograph interpretations and surface and underground investigations. The Gnome explosion caused marked local disturbances at the surface, including fracturing, faulting, evidence of abundant rodent activity, and dispersion of the soil. The shaft walls had only minor fractures, caused primarily by separation along bedding planes. The station at the bottom of the shaft exhibited considerable damage, that could have been cleaned up, and

higher-than-background radioactivity that would have pointed the way toward more definitive underground examination. All of these effects had characteristics which clearly identified them with nuclear blast and which would be difficult to hide from an inspection team. The epicenter of the Gnome event could have been located within 30 meters provided the control system had delineated an area for inspection including the Gnome site, and the inspection team was able to conduct its examination before the evidence was obliterated by man or the elements. One month following the event, the effects were somewhat obscured, but sufficient evidence was still visible to locate the epicenter. Five months after the event the largest fractures could still be seen, however, the epicenter could have been located only within about 50 meters. (auth)

19733 (TRICO-62/03) RAPPORT ANNUEL RELATIF AUX ACTIVITIES DU CENTRE TRICO. PERIODE DE 1 JUIN 1961 AU 31 JUILLET 1962. (Annual Report Relative to the Activities of the Trico Center. Period of June 1, 1961 to July 31, 1962). J. F. Roels (Leopoldville, Congo. Universite Lovanium. Centre Trico). 29p.

The annual report of the TRICO Center at Leopoldville summarizes the activities of the preceding year. The neutron flux in the central opening of the reactor was measured using a filiform detector. The measurements were made at power levels of 1, 5, 10, 20, 30, and 50 kw and show that the maximum flux is located 32 cm below the top grid plate. There is a slight depression of the flux at 34 cm. Some difference is found between the mean values from 1 to 20 kw and from 30 to 50 kw. A verification was made of the thermal neutron flux in the experimental chambers. The first observations on the effect of gamma irradiation on the growth of mung beans are given graphically. The effect of digitoxin on K^{42} exchange in the isolated guinea pig ileum was studied. The results show a parallelism between the action of digitoxin on K exchange and the antagonistic functions of some factors with respect to the activity of chemical mediators. The results are, however, insufficient to determine a mechanism. (J.S.R.)

19734 (TID-4025(Rev.1)(Pt.I)(Suppl.1)) TRANSLATION TITLE LIST AND CROSS REFERENCE GUIDE. Frances E. Stratton, ed. (Division of Technical Information Extension, AEC). 303p.

This publication is Supplement 1 to Translation List and Cross Reference Guide, TID-4025 (Rev. 1)(Pt. 1) and lists the unclassified translations in the files of the Division of Technical Information Extension received between June 30, 1960, and December 31, 1961. The basic volume, TID-4025 (Rev. 1)(Pt. 1) lists translations received prior to June 30, 1960. This supplement includes translations sponsored or prepared by the U. S. Atomic Energy Commission and its contractors, other government agencies in this country and abroad, and commercial and private organizations. Most of the translations in this list have been announced in Nuclear Science Abstracts. Those that are outside the subject scope or of little technical value have not been announced in NSA. (auth)

19735 (UCRL-Trans-934(L)) SHOCK LOAD WAVE IN AN UNDERGROUND EXPLOSION IN ROCKS. N. S. Medvedeva and E. I. Shemyakin. Translated by Sergey Shewchuck from Zh. Prikl. Mekh. i Tekhn. Fiz., No. 6, 78-87 (1961). 20p.

The propagation of shock load waves in rocks, whose behavior during load is described by a nonlinear dependence of the pressures and deformations and by some conditions of "plasticity" was considered. The derived integrals permit the structure of formulas defining the attenuation of the amplitudes of pressure and particle velocity in pressure waves with underground explosions to be shown. (auth)

19736 BASIC CHARACTERISTICS OF A LABORATORY FOR THE MEASUREMENT OF LOW-LEVEL ACTIVITIES. B. Grinberg and Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 65, 9-19(Oct. 1962). (In French)

The precautions taken in low-level laboratories to reduce the background radiation from cosmic radiation, material contamination, and ambient contamination are summarized briefly. (J.S.R.)

19737 NUCLEAR LAB WORK REQUIRES DUAL WATER SUPPLY AND WASTE PIPING SYSTEMS. A. W. R. Oswald (Argonne National Lab., Ill.). Heating, Piping Air Conditioning, 35: 112-13(Apr. 1963).

Dual water supply and waste piping systems were chosen for use at Argonne for protection against contamination of drinking water and for reduction of the volume of wastes requiring special treatment. One water supply system is for domestic (drinking) water and the other for laboratory (nonpotable) water. Laboratory wastes are fed to tanks for monitoring before disposal. (D.L.C.)

19738 APPLICATION OF WORKMEN'S COMPENSATION LAWS TO RADIATION INJURIES. John K. Dane (Liberty Mutual Insurance Co., Boston). J. Occupational Med., 3: 203-8(Apr. 1961).

The problem of determining the application of workmen's compensation acts to radiation injuries is discussed. The problem is complex though, since the ways in which radiation causes injury are not fully understood. Basically, however, radiation damage varies with the severity and duration of the exposure as well as with the amount of the body exposed. Radiation injury is divided into 3 broad classes: obvious and prompt damage to the exposed workman, often followed by some degree of delayed injury; delayed damage to the exposed workman; damage to offspring of the exposed workman. The workmen's compensation acts of all but three jurisdictions provide at least some protection against occupational disease due to radiation. The long latent period of some injuries caused by radiation, creates one of the most difficult problems that must be met in determining the application of a workmen's compensation act to such injury. The workmen's compensation acts of 34 states provide full medical coverage for radiation injuries. The remaining states in which radiation injuries are compensable provide limited medical benefits. Many problems remain before full and complete protection can be afforded workmen exposed to radiation hazards. Since the problems are immediate and the states cannot or will not act in time, a federal system of compensation may be necessary. (TCO)

19739 FORM OF GROUND-WATER FLUCTUATIONS DUE TO NUCLEAR EXPLOSIONS. J. Ineson (Geological Survey, London). Nature, 198: 22-3(Apr. 6, 1963).

Ground water fluctuations due to several nuclear explosions in the September and October 1962 series of U.S.S.R. tests were recorded over a wide area of southern England on unmodified standard automatic water-level recorders. The recording rate did not usually exceed 1.2 in./day. No evidence was found of the arrival of any seismic waves due to this series of firings. Comparison of the microbarometric variations were made for 5 nuclear explosions and an exact inverse relationship was confirmed. Examples are presented graphically and the findings are discussed. (C.H.)

19740 ACCURACY OF RADIOCARBON DATES. W. F. Libby (Univ. of California, Los Angeles). Science, 140: 278-80(Apr. 19, 1963).

The accuracy of dates obtained by the radiocarbon technique is discussed. Apparent discrepancies are examined for geophysical significance and for a general principle of correction. Assay methods are reviewed and data are tabulated showing dates obtained from organic materials found in sites for which the most reliable historical dates are available. Dates obtained using a half-life of 5568 years are compared with those obtained using the recently established half-life of 5730 for C^{14}. The data suggest that Egyptian historical dates beyond 4000 years ago may have errors and that these errors are more or less cumulative with time. Data on the C^{14} content of tree rings of old trees are reviewed and it is concluded that the C^{14} dates are in good agreement with tree-ring chronology curves for the period from 800 to 2400 years ago. Possible reasons for discrepancies in earlier dates are discussed. (C.H.)

19741 LIST OF BIBLIOGRAPHIES ON NUCLEAR ENERGY (WITH ANNOTATIONS). Sergei G. Rodovnichenko, comp. (International Atomic Energy Agency, Vienna). Oct. 1962. 129p. (STI/DOC/11(Vol.2)).

The list is compiled from sources in I.A.E.A. member states. A total of 800 references to bibliographies published or in preparation in English, French, German, Russian, and other languages is presented. The material is classified in groups such as physics and mathematics, thermonuclear processes, chemistry, biological sciences, health and safety, geology, materials, engineering, reactors, accelerators, isotopes, waste, and allied sciences. (J.R.D.)

19742 FUNDAMENTAL NUCLEAR ENERGY RESEARCH, 1962. A Special Report of the United States Atomic Energy Commission, December 1962. (Division of Plans and Reports, AEC). 430p. $2.50(GPO). (TID-18468)

Research sponsored by the AEC on the medical and life sciences, on the physical sciences, on nuclear reactor development and research, on radiation in a natural environment, and on radioactive waste disposal and treatment is reviewed. Separate abstracts were prepared for the five divisions of the report. (D.C.W.)

19743 RESEARCH IN THE MEDICAL AND LIFE SCIENCES. (Division of Plans and Reports, AEC). (TID-18468(p.1-126))

Uses of radiation in studying life processes in plants and animals and in diagnosing, tracing, and treating various diseases are discussed. Equipment used in the work is described as well as the procedures involved. Effects of radiation, recovery from irradiation, toxicity of chemicals and radioelements, atmospheric radioactivity and fallout, and cellular and molecular level studies are examined. Results of studies form a large part of the material. (D.C.W.)

19744 RESEARCH IN THE PHYSICAL SCIENCES. (Division of Plans and Reports, AEC). (TID-18468(p.127-244))

Research on the properties and on the synthesis of the transplutonium elements is discussed as are methods for producing these elements. The national program for their bulk production is also examined. Research in high energy physics, low energy physics, neutron physics and nuclear structure, space radiation, computers, and mathematics is also treated. Aspects of chemistry considered are nuclear chemistry, inorganic and physical chemistry, structural and theoretical chemistry, radiation chemistry, high temperature chemistry, heavy element nuclear chemistry, and materials and systems chemistry. Production, properties, and treatment of materials; alloy theory and the nature of solids; and interaction of radiation with materials are treated under metallurgy and materials. Work in controlled fusion research is also discussed. Research and recent developments in all these areas are examined. (D.C.W.)

19745 NUCLEAR REACTOR RESEARCH AND DEVELOPMENT. (Division of Plans and Reports, AEC). (TID-18468(p.245-310))

Studies made to examine the suitability of various fuels and materials for formation into fuel elements are discussed. Materials for use in reactor cores and components are also being tested. Developments in reactor cooling and instrumentation are reviewed, and research in reactor physics is examined. Development of new methods to reprocess fuel from reactors is reported; and reactor safety studies treating kinetics, fission product release, hazardous chemical reactions, and reactor containment are described. (D.C.W.)

19746 RESEARCH ON RADIATION IN THE ENVIRONMENT. (Division of Plans and Reports, AEC). (TID-18468 (p.311-52))

Various studies made to determine the effects of introducing radiation into a natural environment are discussed. Effects of radiation on plants and animals, water movement, strontium metabolism, water transport of radionuclides, and distribution of fallout of radioisotopes are among the topics covered. (D.C.W.)

19747 TREATMENT AND DISPOSAL OF RADIOACTIVE WASTES. (Division of Plans and Reports, AEC). (TID-18468(p.353-63))

Techniques for treating and disposing of radioactive wastes are discussed. Removal of radioactive elements, disposal in natural salt formations, disposal in permeable and impermeable rock formations, protection for buried wastes, and other aspects are examined. (D.C.W.)

BIOLOGY AND MEDICINE

General and Miscellaneous

Refer also to abstract 19743.

19748 (BLG-167) RECENTS PROGRES DANS L'APPLICATION DE L'ENERGIE NUCLEAIRE EN AGRICULTURE. (Recent Progress on the Application of Nuclear Energy to Agriculture). F. Lievens (Brussels. Centre d'Étude de l'Énergie Nucléaire). Dec. 1962. 26p.

Progress realized since 1958 in agricultural research due to nuclear energy is discussed. Radioisotopes are used as tracers for studies in the fields of plant physiology, animal physiology, entomology, and pedology and as ionizing radiation sources in the fields of plant genetics and food preservation. The applications of radioisotopes in Belgium for agricultural research are reviewed. (auth)

19749 (BNL-777) LABELING OF HUMAN GAMMA GLOBULIN WITH I^{124}. M. W. Greene, L. G. Stang, Jr., and Manny Hillman (Brookhaven National Lab., Upton, N. Y.). Feb. 1963. Contract AT(30-2)-Gen-16. 6p. (BNL-T-293)

A technique was developed to prepare gamma globulin labeled with I^{124}. The major problem involved is obtaining the I^{124} free of impurities in a form suitable for iodination. The effects of iodide carrier, antimony, free chlorine, and the iodine monochloride–protein ratio are described. The method of preparing the I^{124} in a form suitable for labeling proteins is given. (auth)

19750 (PNE-226(P)) CLOSE-IN EFFECTS ON AN UNDERGROUND NUCLEAR DETONATION ON SMALL MAMMALS AND SELECTED INVERTEBRATES. Clive D. Jorgensen (Brigham Young Univ., Provo, Utah). Nov. 1, 1962. Project 62.87 of OPERATION SEDAN. 23p.

Basic ecological data were gathered at the Nevada Proving Grounds before the underground Sedan nuclear detonation in July, 1962. Data are presented from the analysis of vegetation, small animals, and invertebrates. Pre- and post-test procedures are outlined and dosimetry methods are discussed. (C.H.)

19751 (UCRL-10640) STABLE-FLOW FREE-BOUNDARY MIGRATION AND FRACTIONATION OF CELL MIXTURES: SEDIMENTATION AND ELECTROPHORESIS. Howard C. Mel (California. Univ., Berkeley. Lawrence Radiation Lab. and California. Univ., Berkeley. Donner Lab.). Jan. 23, 1963. Contract W-7405-eng-48. 77p.

A number of analytical and preparative problems of complex biological mixtures, requiring speed and mildness of handling, large capacity, and high resolution, can be advantageously attacked by the stable-flow free boundary (STAFLO) method. Experimental and theoretical aspects of STAFLO migration, fractionation, and concentration are analyzed, with particular reference to cell mixtures. Combination gradient profiles of composition, conductivity, pH, etc., can be established almost arbitrarily in a steady-state manner, without the usual gradient mixing devices. The solution to the basic problem of stabilizing flows, without the use of an anticonvective supporting medium, is described in detail. Migration principles, especially for sedimentation and electrophoresis are classified as rate, or equilibrium, and the known and unknown elements of several examined. A simplified Stokes-type treatment is sufficient for semiquantitative description of individual cell sedimentation under 1 g, including calculation of resolution and separation time. A kind of experimental cell behavior called "bombing" is discussed in terms of weak intercellular interaction. Analysis of STAFLO-electrophoresis and STAFLO-sedimentation-electrophoresis in terms of flow, heat production, and other parameters, indicates the basis for preparative cell fractionation, with steady-state times generally of from 2 to 60 minutes. An immediate possibility from such studies is the characterization of cells in mixtures according to sedimentation and electrophoretic mobilities; these latter must eventually be more unequivocally related to cell "density", "size", surface charge and other physical properties. Such relations require more detailed knowledge of cell and solution theory and perhaps better definitions of these properties when applied to cells. As an analytical example of instantaneous determination of a time-dependent transport property, an electrophoretic mobility of a dye is estimated from the slope of a steady-state STAFLO-electrophoresis, migration pattern. (auth)

19752 (AEC-tr-5753) THE RADIOACTIVITY OF SEVERAL SUBMERGED WATER PLANTS. Roland Glaser. Translated from Limnologica (Berlin), 1: 51-63(1962). 19p.

The radioactivity of various water plants was found to be made up of from 50% to over 99% of fission products. Only Stratiotes aloides possesses a very high potassium content, thus its potassium radioactivity accounts for more than 60% of the total. The continuous decline in radioactivity from September 1959 to March 1961 is described and discussed. It was demonstrated by radiochemical and radiophysical methods that the fission-product activity consists almost exclusively of the long-lived $Ce^{144}-Pr^{144}$. The $Sr^{90}-Y^{90}$-content is extremely small. Various enrichment factors for radiocerium in water plants have been calculated. The use of water plants as indicators for radioactive rare earths in natural waters is discussed. (auth)

19753 (JPRS-18633) BIOLOGICAL INDICATORS OF WEAK RADIOACTIVE CONTAMINATIONS IN NORTHERN SEAS. A. F. Fedorov. Translated from Nauchn. Dokl. Vysshei Shkoly, Biol. Nauki, No. 1, 92-5(1963). 6p. (OTS-63-21551)

A method is given for the estimation of the radioactivity of ocean water by means of biological indicators (crayfish). The K^{40} beta activity of crayfish was determined. To convert from radioactivity of the crayfish to radioactivity of the ocean water, a corrective coefficient was introduced that characterizes the ability of the crayfish to concentrate the several radioactive substances found in the water. The general formula for the calculation is given. Total error in the final results does not exceed 10%. It was concluded that biological indication is a most promising method of controlling radiation purity of ocean waters. (P.C.H.)

19754 SCINTILLOGRAPHY IN THYROID DIAGNOSTICS. I. THEORETICAL AND EXPERIMENTAL BASES. THE NORMAL THYROIDAL SCINTIGRAM. D. Ziliotto and P. Carenza (Università, Padua). Acta Isotopica, 1: 55-116 (Mar. 1961). (In Italian)

The availability of scintillography in reproducing thyroid morphology and the more suitable technical conditions with which clinical examination has to be carried out to get the best results are reviewed. Several conclusions are given on the basis of theoretical considerations. A series of experiments were performed with different phantoms of known

characteristics, using a single-hole cylindrical collimator. It was found that if the greatest number of radiations is recorded (slow scanning speed and small scaling factor), the scintigraphic picture will be really magnified and distorted. However, there is the possibility of getting real and little magnified pictures, if: a high-pulse analyzer, which eliminates the secondary low energy radiations, is used; the collimator is put close to the object; and the scanning speed and scaling factor are regulated at a certain level, according to the intensity of radiation. The pictures obtainable using such a procedure show a sufficiently definite outline; contrast appears to be good with a very low background. The appearance of a dark spot in the picture (the so-called hot node) may occur either because of a greater concentration of radioactivity or because of a bigger thickness of the object at that particular point. Hot sources 7 mm in diameter are clearly reproduced on the scintigram even if notably enlarged. The resolution power is satisfactory. Results obtained in 30 patients with normal thyroid are presented. Examinations were carried out, following the technical procedures just mentioned, 24 hr after the administration of a tracer dose of radioiodine (50 to 100 μC). The normal thyroid scan repeats the morphology of the gland; the lateral lobes are clearly outlined; the isthmus does not always appear on the picture, the pyramidal lobe rarely appears. The availability of scanning procedures in evaluating the thyroid size and weight is also discussed. (P.C.H.)

19755 A SCANNER-COMPUTER FOR DETERMINING THE VOLUMES OF CARDIAC CHAMBERS FROM CINE-FLUOROGRAPHIC FILMS. Orland Baker, Jawdat Khalaf, and Carleton B. Chapman (Univ. of Texas, Dallas). Am. Heart J., 62: 797-803(Dec. 1961).

In the use of biplane cineroentgenographic and serial x-ray techniques for measurement of the volume of various cardiac chambers, mechanical and electronic adjuncts to facilitate tracing chamber boundaries and to carry out the necessary calculations were devised. The method for which the described instruments were developed requires the tracing of 2 simultaneously filmed images (35-mm film) recorded at a rate of 30 per sec. The tracing equipment is also described. A scanner is used to measure the diameters of the traced figures and to transmit the result to a photomultiplier tube which then transmits it to a computer. Counting is accomplished by a pulse generator situated between the photomultiplier tube and the computer. A multiplier accepts impulses from the photomultiplier tube in the scanner unit and multiplies the 2 image diameters. The result is transmitted to an accumulator, which sums and stores the results. After the final scan, a stop mark on the slotted paper signals the logic compartment, which, in turn, activates the printer. The scanner-computer was applied to calculation of left ventricular volumes in dogs and in man. (TCO)

19756 A METHOD FOR COLLECTION AND RADIOASSAY OF SPECIMENS OF HUMAN STOOLS. R. L. Hayes (Oak Ridge Inst. of Nuclear Studies, Tenn.). Am. J. Clin. Pathol., 39: 203-5(Feb. 1963).

The collection of specimens of stools, by patients, for diagnostic tests, is often incomplete as a result of the awkward and distasteful nature of the task the person is asked to perform. A simple carton holder, which was designed to fit most toilets, has been used to good advantage in overcoming this problem. (auth)

19757 ON PHOSPHORIMETRY AS QUANTITATIVE MICROANALYSIS WITH APPLICATION TO SOME SUBSTANCES OF BIOCHEMICAL INTEREST. Simon Freed and Mary H. Vise (Brookhaven National Lab., Upton, N. Y.). Anal. Biochem., 5: 338-44(Apr. 1963). (BNL-6329)

Spectrophosphorimetry at liquid nitrogen temperature was used for the quantitative analyses of an enzyme (α-chymotrypsin) and a peptide (N-acetyl-L-tyrosine ethyl ester). Such multipolar substances can be maintained in homogeneous solution at the temperature of liquid nitrogen by a mixture of water (25% by volume), methanol (55%), and ethanol (20%). At this temperature the solution forms a glass and fractures but with the aid of chips of fused silica and an internal standard (benzyl alcohol), a precision of 5 to 10% was reached. (P.C.H.)

19758 CARBON DIOXIDE METABOLISM IN HYDROGEN-ADAPTED SCENEDESMUS. Gabriel Gingras, Richard A. Goldsby, and Melvin Calvin (Univ. of California, Berkeley). Arch. Biochem. Biophys., 100: 178-84(Feb. 1963). (UCRL-9652)

Photoreduction of $C^{14}O_2$ by adapted Scenedesmus gives the same carbon fixation pattern as photosynthesis. Photoreduction is susceptible to progressive inhibition by increasing oxygen tension. The inhibition is parallel. Hydrogenase activity is inhibited in a parallel manner by oxygen tension as measured by tritium exchange. Photoreduction is relatively insensitive to CMU inhibition. Photoreduction at low light intensities is much faster than photosynthesis at the same light intensities. These results are consistent with the ideas that hydrogen contributes electrons directly to CO_2 photoreduction and possibly ATP as well. (auth)

19759 THE AUTORADIOGRAPHIC LOCALIZATION AND DISTRIBUTION OF NEUTRON-ACTIVATED GOLD (Au^{198}) IN SKELETAL TISSUES AND SYNOVIA OF MICE. Edgar A. Tonna, George Brecher, Eugene P. Cronkite, and Irving L. Schwartz (Brookhaven National Lab., Upton, N. Y.). Arthritis Rheumat., 6: 1-10(Feb. 1963). (BNL-6378)

A combination of activation analysis and autoradiography was used for exact localization of gold in tissues. Stable gold (Au^{197}) compounds were injected and the tissues fixed at various intervals thereafter. Subsequent exposure of the tissues to a neutron source activated a fraction of Au^{197} to Au^{198}, which decays with a γ emission of 0.411 Mev and a β emission of an average energy of 0.32 Mev, and which can be localized by radioautography. This technic was used for the localization of Au in the joints of mice following Au thioglucose and Au thiomalate injections. Data are presented for mice injected at 1 or 2 months of age and killed after intervals of 1 or 2 months. Localization of Au following injection of either compound was restricted to the surface of the synovium, the osteogenic layer of the perichondrial periosteum, reticuloendothelial cells of the marrow, and osteogenic cells along the surface of metaphyseal trabeculae and epiphyseal centers of ossification. Au, presumed to have been deposited along bone surfaces in the shaft and epiphyses, was presented within bone some distances parallel to the surfaces, owing to intervening appositional bone growth. Fat pads often contained hot spots clearly localized over individual cells. (TCO)

19760 RENAL DISCRIMINATION BETWEEN CALCIUM AND STRONTIUM. MacKenzie Walser and Brian H. B. Robinson (Johns Hopkins Univ., Baltimore). Bull. Johns Hopkins Hosp., 111: 20-34(July 1962).

The ratio of excreted (Sr_u) to filtered (Sr_0) radiostrontium (Sr^{85}) was compared with the ratio of excreted (Ca_u) to filtered (Ca_0) calcium in human subjects and dogs undergoing a variety of diuretic procedures. The relation Sr_u/Sr_0 =

$(Ca_u/Ca_0)^{0.7}$ serves to predict Sr_u/Sr_0 from Ca_u/Ca_0 with a standard error of estimate of 15% over a wide range of variation (30- to 200-fold) in the 2 quantities. The equation can be derived from the assumptions that the 2 ions are reabsorbed at rates proportional to the local concentrations in the tubular fluid, and that the rate constant for Sr reabsorption is always 0.7 times that for Ca reabsorption. This relation was not affected by adrenocortical activity (in man), parathyroid activity, hypercalcemia, acid-base balance, Mg clearance, or diuretics (chlorothiazide or hydrochlorothiazide). Sulfate or ferrocyanide infusion was also without effect, presumably because the affinity of each of the 2 anions for Ca is similar to its affinity for Sr. Citrate, which binds Ca more strongly, diminishes renal discrimination between Ca and Sr. Although this relation has high predictive value ($r^* = 0.98$), it does not establish that the reabsorption of Ca and Sr are first-order processes nor that the 2 ions share a common mechanism. (H.H.D.)

19761 IRRADIATION OF LYMPH NODES. C. M. E. Matthews (Hammersmith Hospital, London). Clin. Sci., 22: 209-22(Apr. 1962).

A method was sought for the irradiation of lymph nodes. Bi^{206} attached to denatured protein and injected subcutaneously gave a high concentration of activity in draining lymph nodes and in kidney. Also, some activity remained at or near the site of injection. This offers a possible method of irradiating draining lymph nodes, either to reduce the immunological response for grafting or for radiotherapy. Factors affecting lymph node uptake are discussed. Bi^{206} protein has advantages over Au^{198}, since as a pure γ emitter it would give a more uniform dose for radiotherapy of an organ with uneven uptake, and this might be particularly important if uptake is low in diseased parts of lymph nodes. For a diagnostic test it would do less damage to healthy tissue. (TCO)

19762 EARLY ENTRANCE OF C^{14} INTO PHOSPHATIDES DURING PHOTOSYNTHESIS IN THE LEAVES OF PRIMULA OBCONIA. N. I. Zakharova. Dokl. Akad. Nauk SSSR, 149: 202-4(Mar. 1, 1963). (In Russian)

Experimental data indicated that the primary products of photosynthesis contain combined phosphatides with free amino groups of the phosphatidyl-ethanol amine and phosphatidyl-serine type. CO_2 may be included early in the metabolism not only of carbohydrates and proteins but also of lipids in photosynthesis. The experiments were done at 18 to 20°C with leaf cuttings in an atmosphere containing 0.3% CO_2 (from $BaC^{14}O_3$, specific activity 77 mc/g), which were exposed to a light source 25 cm away. The primary photosynthesis product, precipitated with acetone from a water extract of the liquid-nitrogen-frozen leaves, contained 4.2 to 4.7% free lipoid. Based on the amount of C^{14}, this is within the limits of error of the experiment. In addition, the C^{14}-containing material did not move upward in $CCl_4 - CH_3OH$ (2:1) on a paper chromatograph. A significant amount of the C^{14}-labeled compound was extracted with methanol containing 85% formic acid (8:2). The alkali-hydrolysis product was also analyzed chromatographically. (TTT)

19763 GENETIC INTERPRETATION OF CHIASMATA IN DELPHINIUM. H. K. Jain and S. L. Basak (Indian Agricultural Research Inst., New Delhi). Genetics, 48: 329-39 (Mar. 1963).

Asymmetry of the karyotype combined with x-ray induced interchange heterozygosity has been made use of in Delphinium to study the relationship between chiasmata and crossing-over. The translocation multiples in two heterozygous plants were analyzed for chiasma formation in the interstitial segments, and for equational and reductional separation of the chromosomes having these segments. A close correspondence between the frequency of chiasma formation and that of equational separation of the chromatids was found in the first heterozygote. In the second, the invariable non-formation of chiasmata in the interstitial regions was found to be associated with non-varying reductional separation of the two chromosomes. These observations indicating a one-to-one relationship between chiasmata and genetic recombination have been further discussed in the context of some recent suggestions on the mechanism of crossing-over. (auth)

19764 STUDIES WITH PURPLE ADENINE MUTANTS IN NEUROSPORA CRASSA. V. EVIDENCE FOR ALLELIC COMPLEMENTATION AMONG ad-3B MUTANTS. Frederick J. de Serres (Oak Ridge National Lab., Tenn.). Genetics, 48: 351-60(Mar. 1963).

Heterokaryon tests of all possible combinations of 161 ad-3B mutants of independent origin were made in duplicate in test tubes containing liquid minimal medium. Only 112 (0.4 percent) of the 25,760 pairwise combinations involving different mutants were positive. All combinations showing positive tests involved one of four leaky mutants and 14 nonleaky mutants. Growth tube studies on the heterokaryons revealed a wide range of growth rates from wild type to only slightly faster than the rate of leaky mutant itself. These tests show that the complementation map of the ad-3B cistron consists of at least two complementation subgroups or complons. (auth)

19765 GENETICS OF NATURAL POPULATIONS. XXXII. INBREEDING AND THE MUTATIONAL AND BALANCED GENETIC LOADS IN NATURAL POPULATIONS OF DROSOPHILA PSEUDOOBSCURA. Th. Dobzhansky, B. Spassky, and T. Tidwell (Rockefeller Inst., New York). Genetics, 48: 361-73(Mar. 1963).

Samples of natural populations of Drosophila pseudoobscura were taken in certain localities in California and in Arizona. The laboratory-bred progeny of the wild flies were utilized to make crosses, the offspring of which had inbreeding coefficients of F = 0, 0.125 and 0.250. Batches of 50 eggs (in one of the experiments with replications) were taken from each cross, and the numbers of adults developing from these eggs were recorded. As expected, the percent survival was lower in inbred than in outbred progenies. The A and B statistics were computed; the B/A ratios varied from 4.5 to 5.8. The estimates of the genetic loads turned out to be no less than 0.5 and no more than 0.9 lethal equivalents per average gamete. Series of crosses utilizing appropriate genetic markers in the second, third, and fourth chromosomes were then made in order to estimate the proportions of the lethal and semilethal chromosomes and the mean viabilities of the homozygotes and heterozygotes for these chromosomes. The estimate of the genetic load derived with the aid of this method comes to about 1.4 lethal equivalents per average gamete. It is suggested that an appreciable fraction of the genetic load is balanced, and that the components of the genetic load tend to act synergistically when brought to manifestation in homozygous condition. (auth)

19766 THE EFFICIENCY OF TETRACYCLINE IN REMOVING RADIOSTRONTIUM FROM RATS. Hylton Smith (United Kingdom Atomic Energy Authority, Annan, Scotland). Intern. J. Radiation Biol., 6: 197-8(Feb. 1963). (In English)

Tetracycline did not increase the rate of excretion of Sr^{85} in rats. Data are presented from a study on rats given

an intraperitoneal injection of tetracycline, either as a single dose of 30 mg or a multiple dose of 150 mg, after the administration of $Sr^{85}Cl$. (C.H.)

19767 A STUDY OF THE MECHANISM OF CONVERSION OF GALACTOSE TO GLUCOSE IN THE INTACT RAT. Bernice D. Kohn, Rita C. Hoffmann, and Paul Kohn (Argonne National Lab., Ill. and Univ. of Illinois, Chicago). J. Biol. Chem., 238: 1193-5(Apr. 1963). (TID-17449)

The conversion of galactose to glucose was studied by administering galactose labeled uniformly with C^{14} and at position 4 with tritium to rats and examining glucose obtained from liver glycogen. The ratio of tritium to C^{14} in the isolated glucose was unchanged from that in the administered galactose, indicating that if the mechanism of conversion involved the participation of NAD^+ in an oxidation-reduction process, the NAD^+ must have been bound to the enzyme and brought about both the oxidation and the reduction. Other possible mechanisms of conversion are discussed from the viewpoint of binding by the enzyme of reactants in the conversion. (auth)

19768 FETAL UPTAKE OF ORALLY ADMINISTERED RADIOCALCIUM IN RATS. James W. Bawden and James W. Osborne (Univ. of Iowa, Iowa City). J. Dental Res., 41: 1475(Nov.-Dec. 1962).

Attempts were made to develop a reliable method of Ca^{45} administration to pregnant rats and to determine the fetal uptake of Ca^{45} during such treatment. Female rats 120 days old, on a diet containing 1.42% Ca, were mated and daily doses of Ca^{45} were given by stomach tube, each dose containing ~0.5 mμ Ca^{45} and 0.005 mg of total Ca. The doses were given each day throughout gestation. The litters were collected immediately after parturition, etherized, dried, and ashed at 1000°C. The ash content from each newborn rat was taken up into solution with N HCl, and aliquots were plated out on planchets. The samples, along with samples of Ca^{45} solution used in administration to the mother, were counted with a windowless gas flow counter connected to a scaling assembly. Self-absorption considerations characteristic of the assay of Ca^{45} were investigated, and data on aliquot sizes ranging from 0.1 to 1.0 ml revealed a linear relation between aliquot size and count rate. Thus correction for self-absorption was not necessary. The data showed that an average of 4.04% (±0.31) of the orally administered Ca^{45} dose was recovered from the litters. (H.H.D.)

19769 ADOPTIVE TOLERANCE: TRANSFER OF THE TOLERANT STATE. Bertie F. Argyris (Carnegie Institution of Washington, Baltimore). J. Immunol., 90: 29-34 (Jan. 1963).

Tolerance to skin homografts in C3H mice was induced by intravenous neonatal injection of CBA spleen cells, and the lymphoid cells from the tolerant mice were transferred to lethally (750-r) x-irradiated recipient mice of both host and donor strain. The irradiated recipient mice were subsequently tested with appropriate skin grafts to determine whether the tissues transferred from the tolerant animal continue their tolerant behavior in a new environment. The fate of skin grafts from a third unrelated strain (C57BL6) of mice on the chimeras determined whether the transferred cells, although mutually tolerant, were still capable of an immunologic response. The results showed that lymphoid cells from tolerant mice can be successfully transferred to a new environment without affecting their tolerant behavior. In addition to being mutually tolerant, the host and donor cells from the tolerant animal tolerated each other's type of skin grafts. The tolerance was not due to a general impairment of the immune capacity but to a specific inhibition of the immunologic response. The results suggest that the graft-vs-host tolerance in the newborn C3H mouse injected with adult CBA strain spleen cells was not due to immunologic paralysis. (TCO)

19770 ASSAY OF CHEMICAL AND RADIOACTIVE AGENTS FOR INHIBITION OF LOCAL (TOPICAL) AND SYSTEMIC (METASTATIC) TUMOR CELL SPREAD IN THE MOUSE. Horace Goldie and Mathew Walker (Meharry Medical Coll., Nashville). J. Natl. Med. Assoc., 54: 22-7 (Jan. 1962).

Methods for the quantitative assay of the effect of various physical and chemical agents on local and systemic (metastatic) tumor cell spread are discussed. Techniques are given for: assay of tumor cell concentration in the fluid; computation of the mitotic index; estimate of the volume of ascitic fluid; recording spontaneous implantation; induced implantation; experimental infiltration of subcutaneous tissue with free ascitic tumor cells; extent of tissue invasion by free cells, intrascrotal inoculation and treatment; detection of tumor cells in organs by intraperitoneal grafts; and peritumoral infiltration. The methods are attempts to outline the prevention of secondary growth as a separate procedure, which should be an adjuvant to the cure (surgical, radiological, or pharmacological) of the primary growth. (P.C.H.)

19771 CIVIL DEFENSE AGAINST ATOMIC ATTACK: TECHNIQUES AND ORGANIZATION OF NURSING CARE FOR VICTIMS OF ATOMIC EXPLOSIONS. Mohamad Abdullah. Madjalah Kedokteran Indones., 10: 299-305(Aug. 1960).

19772 A SPECIAL COBALT APPLICATOR FOR THE PREOPERATIVE IRRADIATION OF CANCER OF THE UTERINE CERVIX. Gyozo Lehoczky, G. Cserep, and L. Bozoky. Magy. Onkol., 6: 129-37(Aug. 1962).

Construction and use of the device are described. (H.H.D.)

19773 RADIOACTIVE ISOTOPES. G. Milhaud (Institut Pasteur, Paris). Maroc Med., 41: 295-300(Mar. 1962).

The application of radioisotopes in various diagnostic and therapeutic techniques is discussed, particularly with relation to the clinical information obtained and the hazards involved. (H.H.D.)

19774 CONSIDERATION OF THE APPLICATION OF NATURAL RADIOACTIVITY FOR THERAPEUTIC PURPOSES. M. Miljanic (Balneo-Klimatolski Institut, Zagreb). Med. Glasnik, 16: 120-3(Mar. 1962).

Possible medical uses of radioactive mineral waters are discussed. (H.H.D.)

19775 THYROID DISEASE: A STUDY IN HIROSHIMA, JAPAN. Dorothy R. Hollingsworth, Howard B. Hamilton, Hideya Tamagaki, and Gilbert W. Beebe (Atomic Bomb Casualty Commission, Hiroshima-Nagasaki). Medicine, 42: 47-71(Jan. 1963).

The relation of thyroid disease to single, whole-body exposure to ionizing radiation was studied in matched samples of exposed and non-exposed subjects residing in Hiroshima, Japan. Clinical investigations were conducted on 169 patients with thyroid disease, of whom 152 were females. It was concluded that a number of etiological factors are significant in the production of simple goiter. Carcinoma of the thyroid was diagnosed in 12 patients. Although a greater number of malignancies were seen among the most heavily exposed, differences among distance groups was not statistically significant. 168 references. (C.H.)

19776 VITAMIN D_3 INHIBITION OF RADIOCALCIUM BINDING BY CHICK INTESTINAL HOMOGENATES. R. H. Wasserman and A. N. Taylor (Cornell Univ., Ithaca, N. Y.). Nature, 198: 30-2(Apr. 6, 1963).

Results are reported from tracer studies, using Ca^{45}, on the effect of vitamin D on the binding capacity for Ca^{++} of chick intestinal homogenates. The effects of added Ca and citrate and pH were measured. Possible mechanisms of vitamin D action on Ca metabolism are discussed. (C.H.)

19777 INVESTIGATION OF THE USE OF COLLOIDAL CHROMIUM RADIOPHOSPHATE IN THE TREATMENT OF CHRONIC LEUKEMIAS. EXPERIMENTAL FINDINGS AND CLINICAL APPLICATIONS AND RESULTS. A. Chevallier, G. Methlin, and M. Jacques (Faculte de Medecine, Strasbourg). Pathol. Biol. Semaine Hop., 10: 1473-84(Oct. 1962).

$CrP^{32}O_4$ was prepared by reduction of CrO_3 in the presence of $H_3P^{32}O_4$ and was stabilized in colloidal form by gelatin or serum albumin. When injected intravenously in rats, 97.7% was taken up by organs containing reticuloendothelial cells (spleen, liver, lung, and bone marrow). By reducing the particulate size of $CrPO_4$, the uptake by spleen and bone marrow was increased whereas uptake in liver was diminished. In rats injected intravenously with 50 mC $CrPO_4$, the estimated dose to various organs was: liver 5282 rad, lung 582, spleen 4476, and bone marrow 484. No pathologic changes were noted in the liver at this dose. In rats given a 10-fold higher dose (500 mC, or equivalent to a 100-mC dose in man), spleen weight fell to one-third normal by 15 days, and bone marrow showed a 50% decrease in nucleated cells. Twelve months later the marrow had regenerated and the animals were in good health. In contrast, injection of the same dose of soluble radiophosphate produced severe, irreversible aplasia and death of the animals. Therapeutic results are described in 19 patients; 9 with myeloid leukemia received 5-mC and 10 with lymphoid leukemia received 3.5-mC doses of $CrP^{32}O_4$. The average duration of remission was 7 and 12 months, respectively. The injections were promptly followed by a fall in circulating leukocytes, relief from cervical and axillary lymphadenopathy, and a regression of splenomegaly in about 2 months. However, in spite of repeated injections, death from leukemia was not prevented. (H.H.D.)

19778 IDENTIFICATION OF ULTRAVIOLET-INDUCED THYMINE DIMERS IN DNA BY ABSORBANCE MEASUREMENTS. R. B. Setlow and W. L. Carrier (Oak Ridge National Lab., Tenn.). Photochem. Photobiol., 2: 49-57(1963).

The irradiation of native DNA's by ultraviolet radiation of different wavelengths changes their absorption spectra. The changes are similar to those found for the formulation of dimers between adjacent thymines in polynucleotide chains. The decreases in absorbance at 270 mμ produced by 280 mμ irradiation are reversed to a large extent by subsequent 239 mμ irradiation. The magnitude of the absorbance changes produced by large doses of 280 mμ corresponds to the formation of dimers between approximately 50 per cent of all the TT sequences in the DNA. An incident dose of 100 erg/mm^2 of 280 mμ radiation forms about one dimer per molecule of calf thymus DNA of molecular weight 6×10^6. The irradiation of heat-denatured DNA produces larger absorbance changes than are observed in native DNA. The absorbance changes in denatured DNA arise in part from a heat-reversible reaction, presumably involving cytidine, part from the formation of thymine dimers, and part from some unknown photoproducts. The reversal of thymine dimers by short wave length irradiation does not produce an equivalent change in the melting temperature of the DNA. (auth)

19779 THE DETERMINATION OF GOLD IN HUMAN LIVER BY THERMAL NEUTRON ACTIVATION ANALYSIS. R. M. Parr and D. M. Taylor (Royal Cancer Hospital, London). Phys. Med. Biol., 8: 43-50(Apr. 1963).

A method for the determination of gold in biological materials by neutron activation analysis is described. Using this method the gold concentration in 32 samples of human liver was found to range from 13 to 790 μμg/g wet tissue with a median value of 57 μμg/g. (auth)

19780 THE EXPERIMENTAL DETERMINATION OF THE DOSE DISTRIBUTION AROUND YTTRIUM-90 SOURCES SUITABLE FOR PITUITARY IMPLANTATION. Elizabeth Jones, J. R. Mallard, and M. S. Elmanharawy (Hammersmith Hospital, London). Phys. Med. Biol., 8: 59-73(Apr. 1963).

The sources under consideration are of sintered yttria rod (Y^{90}), 1 mm in diameter and from 2 to 8 mm in length. The method of evaluating depth dose data is described; Mix D is used as a tissue-equivalent absorber and film as a detector, calibrated by means of a standard Sr^{90} plaque. The validity of this method is discussed. The data presented consist of calibration factors (e.g., a 6 mm rod of 1 mc activity delivers at a point on the minor axis 1 mm away from the surface of the rod a total dose of 460,000 rads), depth dose curves, and isodose contours. The depth dose curves are exponential in form, the approximate values of the half-value layer thickness in unit density material being 1 mm. The isodose contours are shown to be approximately elliptical in form. From the data presented it is possible to construct isodose surfaces around these rods of Y^{90} within known limits of error. (auth)

19781 THE DOSIMETRY OF YTTRIUM-90 SOURCES SUITABLE FOR PITUITARY IMPLANTATION: COMPARISON OF THEORETICAL AND EXPERIMENTAL RESULTS. Elizabeth Jones and J. R. Mallard (Hammersmith Hospital, London). Phys. Med. Biol., 8: 75-82(Apr. 1963).

Theoretical calculations, based on the treatment of Loevinger et al. (1956), are made of the β ray dose and its distribution around rods of yttria (Y^{90}) 1 mm in diameter. The results are in good agreement with the measured ones. In addition, there is a notable consistency in the dose levels reported for sources of Y^{90}. (auth)

19782 AN HYPOTHESIS CONCERNING RNA METABOLISM AND AGING. V. J. Wulff, H. Quastler, and F. G. Sherman (Masonic Research Lab., Utica, N. Y.; Brookhaven National Lab., Upton, N. Y.; and Syracuse Univ., N. Y.). Proc. Natl. Acad. Sci. U. S., 48: 1373-5(Aug. 1962). (TID-16046)

Marked differences were observed in the pattern of H^3-cytidine incorporation into ribonucleic acid (RNA) in the tissues of young and old mice and rats. An hypothesis on aging is presented that is based on the assumed connection between aging and the occurrence of irreversible changes in molecular structure. (C.H.)

19783 THE FIXATION OF RADIOPOTASSIUM IN AUTO- AND HOMOGRAFTS OF SKIN IN THE RAT. Vieri Scortecci (Universita, Milan). Ric. Sci., Rend., 2: 193-8 (Sept. 1962). (In Italian)

The potassium fixation of auto- and homografts of skin in the rat was studied using K^{42}. A slightly higher uptake of K was observed in the autograft than in the homograft as early as the 4th day after grafting. (auth)

19784 CHROMOSOME DUPLICATION AND MUTATION. Richard F. Kimball (Oak Ridge National Lab., Tenn.). Strahlentherapie, Sonderbaende, 51: 116-22(1962). (In English)

Results are reported from studies on radioinduced recessive lethal and slow growth mutations in paramecium. The best hypothesis to account for all results seems to be that radiation of any kind produces localized alterations in the chromosomes. These alterations are subject to metabolic repair until DNA synthesis (i.e., chromosome duplication), at which time those remaining are converted to self-replicating mutation. Whether any conversion to mutation occurs before DNA synthesis is still unsettled. Our direct evidence is for loss of damage, i.e., repair, before DNA synthesis and conversion during synthesis. Furthermore, repair is especially efficient during G2 or early prophase, but just why is not clear. This hypothesis shares many features with the idea of metabolic repair of chromosome breaks through restitutional reunion. However, there are also dissimilarities, especially in that DNA synthesis has been shown not to be an important end point for reunion. (auth)

19785 PRIMENENIE MIKROELEMENTOV, POLIMEROV I RADIOAKTIVNYKH IZOTOPOV V SEL'SKOM KHOZYAISTVE. VYIUSK II. (Applications of Microelements, Polymers, and Radioactive Isotopes in Agriculture. Volume II). Kiev, Publishing House of Literature on Agriculture, Ukrainian SSR, 1962. 244p.

Thirty-eight articles are included on applications of microelements, high-molecular weight compounds, and radioisotopes in research laboratories and collective and state farms. A survey is made of experiments using ionizing radiations in raising crops and of the importance of natural irradiation of soils and fertilizers. Tracer studies of plant mineralization using phosphorus, calcium, and sulfur radioisotopes are discussed. The book is designed for scientists in agricultural research. (R.V.J.)

19786 RADIOISOTOPES IN THE STUDY OF THE FATE OF INSECTICIDES APPLIED TO ANIMALS AND PLANTS. F. W. Plapp, Jr. and D. A. Lindquist (Department of Agriculture, Corvallis, Ore.). IAEA Preprint SM-40/37. 26p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

The use of radioisotopes has been of great value in the development of systemic insecticides for the control of insect pests of both plants and animals. General patterns of absorption, circulation and localization, metabolism, and the site and nature of residues have been determined more rapidly through the use of labeled materials than would have been possible by other available methods of analysis. Information gained in studies with labeled insecticides has enabled entomologists to learn why some chemicals are relatively more toxic to insects than to mammals and why some are safer for use with certain types of mammals than with others. Results of these studies have led to the development of new methods for controlling insect pests. Hitherto unsuspected metabolic pathways have been elucidated and new methods of analysis have been developed. Labeled insecticides have been essential in developing basic information on plant systemics. Radioisotopes have made it possible to follow the absorption, translocation and metabolism of systemic insecticides in plants. Also, the chemicals can be followed into insects that feed on treated plants and their metabolism and excretion can then be studied in the insects. By utilizing labeled materials it has been shown that cotton plants grown from seed treated with systemic insecticides absorb less than 5 per cent of the applied dose. Other studies have demonstrated that systemic insecticides are not readily translocated from treated leaves to new growth. (auth)

Biochemistry, Nutrition, and Toxicology

Refer also to abstracts 20233 and 20234.

19787 (AERE-R-4196) THE ELEMENTARY COMPOSITION OF MAMMALIAN BLOOD. H. J. M. Bowen (United Kingdom Atomic Energy Authority. Research Group. Wantage Research Lab., Wantage, Berks, England). Feb. 1963. 44p.

A list is presented of a large number of values recorded in the literature for 62 chemical elements in mammalian blood, red cells, plasma, and serum, together with the number of determinations and the method of analysis in each case. A table of mean values is also included, and all values have been recalculated to $\mu g/ml$ for intercomparison. 588 references. (auth)

19788 (CRER-1134) IMPROVED NITRIC SEPARATION OF STRONTIUM. J. F. MacDonald (Atomic Energy of Canada Ltd., Chalk River, Ont.). Mar. 1963. 14p. (AECL-1714)

A new method is described that effects rapid separation of Sr^{90} from Ca in bone. Accuracy, reliability, and chemical recovery obtained with the method were compared with those observed using an ion-exchange method. Application to other environmental samples is discussed. Description of the complete procedure is appended. (auth)

19789 (TID-18004) DISTRIBUTION OF URANIUM IN THE HUMAN BODY. Final Report. (New York Univ., New York. Coll. of Engineering). Dec. 1962. Contract AT(30-1)-2518. 120p.

The distribution of uranium in the tissues of the human body after the injection of from 4 to 50 mg of U was measured. A mathematical procedure is described for use in finding the relationship between time and the concentration of U in the various tissues. Data on 11 men who accidentally ingested U and measurements made of the amount of U excreted in a number of urine samples spread over time were studied with a view toward eliciting the underlying mechanism involved and the development of techniques for estimating the amount of U ingested, from each urine sample. (C.H.)

19790 (TID-18422) SOME ASPECTS OF CALCIUM METABOLISM IN X-IRRADIATED RABBITS. Robert E. Milani (Rochester, N. Y. Univ.). 1954. Contract [W-7405-eng-49]. 70p.

The Ca concentration in locally irradiated muscle tissues increased with a maximum level occurring 48 hr after exposure. This condition appears to be a primary effect of the radiation and to be reversible. An increase in the inorganic phosphate of irradiated muscle tissue also took place within 48 hr after exposure. A depression in the plasma Ca concentration was noted in most of the rabbits given 2000 r whole-body x-radiation. It occurred for a short period anywhere from the first through the third day. The Ca content of cecums from animals given 2000 r whole-body irradiation was found to be elevated as much as 50% on the average. The amount of Ca diverted to the cecum was sufficient to account for the fall in blood level to the tetany condition. The Ca concentration of brain tissue from

animals given 2000 r whole-body irradiation or locally to the head was increased after exposure about 45% on the average. There seemed to be a greater increase in the Ca concentration in the cerebellar than in the cerebral portion. (auth)

19791 (TID-18499) THE EFFECTS OF TRITIUM OXIDE ON AQUATIC ORGANISMS. Summary and Progress Report, June 1, 1962 through July 31, 1963. Donald M. Skauen (Connecticut. Univ., Storrs). Apr. 5, 1963. Contract AT(30-1)-3039. 11p.

A large colony of guppies was raised under rigidly controlled conditions. Records were kept on the vital statistics of each brood reared. A wealth of information about guppies was obtained which will serve as comparative data for future studies on fish raised in a T_2O environment. Results of a pilot study using 5 guppies showed that none of the tissue samples contained T_2O. This may indicate lack of exchange of T for H or lack of assimilation or tissue binding. (auth)

19792 STUDIES ON INCORPORATION OF DEUTERIUM INTO BACTERIA. Rosalie de Giovanni and S. Zamenhof (Columbia Univ., New York). Biochem. J., 87: 79-82(Apr. 1963).

Cells of Escherichia coli were grown in synchronized and non-synchronized cultures in a medium containing 92% of deuterium oxide. The incorporation of deuterium into cells was 15.1% after four generations and 34.3% after eight generations, indicating selectivity of incorporation dependent on length of exposure to deuterium. Cell distortion and increase in mutation rate could be correlated with the amount of incorporation. The incorporation of deuterium into the nitrogenous bases of the DNA of these cells was determined. (auth)

19793 INHIBITOR, ISOTOPIC AND KINETIC STUDIES OF HYDROGEN DEHYDROGENASE. D. H. Bone (Yale Univ., New Haven). Biochim. Biophys. Acta, 67: 589-98 (Apr. 9, 1963). (In English)

The oxidized form of hydrogen dehydrogenase of Hydrogenomonas ruhlandii was inhibited by BAL, cyanide, dithionite, sulfide, sulfite, and thioglycolate. Reduction of the dehydrogenase with DPNH or H_2 resulted in a diminished effect of the inhibitors, with the exception of p-chloromercuribenzoate, which inhibited only the reduced enzyme. Information from kinetic analysis and inhibitor studies indicated that the enzyme is reduced with H_2 to give a proton and that this is followed by the oxidation of the reduced enzyme with DPN to give DPNH. The enzyme catalyzes an exchange between H_2 and HTO and also between HTO and DPNH. Analysis of DPN enzymically reduced T_2 showed that T is in the β-position of DPNH. The enzyme action has a lag phase, which can be eliminated by preincubation with H_2 or DPNH. (auth)

19794 QUANTITATIVE ANALYSIS OF INORGANIC SUBSTANCES IN THE BODY. A METHOD USING X RAYS OF DIFFERENT QUALITIES. H. Oeser and E. Krokowski (Freie Universität, Berlin and Westend Hospital, Charlottenburg, Ger.). Brit. J. Radiol., 36: 274-9(Apr. 1963).

A method is described whereby the amounts of inorganic substances in any part of the body can be determined. The method uses the different absorption of low and high kilovoltage x rays. The radiographs taken are photo-electrically evaluated and compared. Results obtained with the method are presented and discussed. (auth)

19795 USE OF COMPUTERS IN MEASURING BODY ELECTROLYTES BY GAMMA SPECTROMETRY. George R. Meneely, Con O. T. Ball, John Lynn Ferguson, Daniel D. Payne, A. Ross Lorimer, Raymond L. Weiland, Howard L. Rolf, and Robert M. Heyssel (Vanderbilt Univ., Nashville). Circulation Res., 11: 539-48(Sept. 1962).

Whole-body potassium levels were investigated as a function of age, sex, and race by whole-body counting of K^{40}. A whole-body counter was calibrated for body K. Subjects were selected to embrace a wide spectrum of stature and habitus. Data were processed using an IBM-650 program. The time required to read a subject's data, process them, and punch out results was approximately three minutes. (C.H.)

19796 STRONTIUM-90 AND CALCIUM IN MILK OF MINIATURE SWINE. R. O. McClellan and L. K. Bustad (General Electric Co., Richland, Wash.). Intern. J. Radiation Biol., 6: 173-80(Feb. 1963). (HW-SA-2676). (In English)

The Sr^{90} and calcium contents of diet, plasma, and milk were determined for nine young adult primiparous miniature swine fed 25 or 125 μc of Sr^{90} daily. The mean Sr^{90}/Ca of the milk was 0.10 that of the diet; the mean Sr^{90}/Ca of plasma was 0.23 that of the diet; and the mean Sr^{90}/Ca of milk was 0.38 that of the plasma. With increasing time after parturition, the daily content of Sr^{90} in milk increased progressively from 1 to 2% to 3% and more of the Sr^{90} ingested each day by the dam. The calcium content of milk also increased with time after parturition, but the Sr^{90} and calcium concentrations changed in such a way that the ratio of the Sr^{90}/Ca of the milk increased relative to the Sr^{90}/Ca of diet. (auth)

19797 RUBIDIUM AND CESIUM ENTRY, AND CATION INTERACTION IN FROG SKELETAL MUSCLE. Valerie Bolingbroke, E. J. Harris, and R. A. Sjodin (University Coll., London). J. Physiol. 157: 289-305(Jan. 1961).

Rb and Cs uptake by frog sartorius muscle was measured and the interaction between K, Rb, and Cs studied. Uptake of Rb from various mixtures of Rb and Na salts and the uptake of Cs from various mixtures of Cs and Na salts fell along single curves for a given temperature when plotted against a function of concentration × time of exposure. The relative exchangeabilities of K for K, Rb, and Cs, respectively, were 1 : 0.2 : 0.04. Uptakes of Rb or Cs from mixtures with K or with each other are shown to be consistent with predictions. Entry of Rb into previously K-depleted muscles, so that Na is displaced by Rb, was faster than the interchange of Rb with the muscle K. Uptake of labeled K from mixtures with Rb or Cs followed a course consistent with the hypothesis that when Rb or Cs has entered the ion-exchange region the K exchange is slowed down. In the case of Rb + K mixtures, the K exchange ultimately fell to the same rate as holds for Rb-K interchange, but Cs took longer to exert its full inhibitory effect. Experiments in which the internal-external resistance of fibers from a pair of muscles were measured, in solutions containing respectively 3 mm K or Rb with Na methyl sulfate, showed that the values in the Rb solution were 2 to 4 times those in the K solution. Experiments also indicated that the Cl exchange process follows the same pattern as that described for the cations. (TCO)

19798 UPTAKE AND RETENTION OF Cs^{137} BY A BLUE-GREEN ALGA IN CONTINUOUS FLOW AND BATCH CULTURE SYSTEMS. J. R. Watts and R. S. Harvey (E. I. du Pont de Nemours and Co., Aiken, S. C.). Limnol. Oceanog., 8: 45-9(Jan. 1963).

The uptake and retention patterns of the blue-green alga, Plectonema purpureum, were determined by exposing laboratory cultures to various concentrations of Cs^{137} in both

continuous flow and batch tests. A simplified laboratory apparatus was devised to provide a continuous flow of radioactive culture media through multiple flasks containing the filamentous algae, which were set up in parallel. In each type of test, the maximum uptakes of Cs^{137} by the algae were proportional to the concentrations of Cs^{137} in the media. However, algal uptakes were higher by a factor of 7 in the continuous flow tests than in batch tests. Only 10% of the Cs^{137} was retained by the algae three days after the algae were transferred into cesium-free media. (auth)

19799 USE OF THE LIVING CHICK EMBRYO AS A BIOLOGICAL INDICATOR OF THE EFFECTIVENESS OF CHELATING AGENTS. H. Smith and I. V. Chapman (United Kingdom Atomic Energy Authority, Annan, Dumfriesshire, Scotland). Nature, 198: 32-3(Apr. 6, 1963).

The toxic effects of tetracycline and the effectiveness of this compound as a chelate in the removal of Sr^{89} were measured in 11-day-old chick embryos. Doses of tetracycline up to 4 mg had no effect on growth but higher doses caused stunted, deformed embryos with gross degenerative changes in the liver. Extensive deposition in the skeleton was observed. Tetracycline did not inhibit the deposition of Sr^{89} in bone. (C.H.)

19800 RADIONUCLIDE MINERAL STUDIES: RELATION OF BREED, AGE, AND VITAMIN B_{12} TO INORGANIC S^{35} METABOLISM IN CHICKS. W. G. Martin and H. Patrick (Univ. of West Virginia, Morgantown). Poultry Sci., 39: 282-6(Mar. 1960).

Investigation of the effect of vitamin B_{12} on the ability of the young chick to incorporate inorganic S^{35} in bone tissue, when fed both simplified and practical type diets, indicated that, of the skeletal structures examined, the sternum was generally the most active site of inorganic S^{35} incorporation. This may be due to its higher content of cartilage tissue than tibia. A significantly higher growth response was observed from chicks fed rations supplemented with vitamin B_{12}. White Leghorn chicks consistently showed a higher S^{35} uptake rate over that exhibited by the New Hampshire and the White Leghorn × New Hampshire cross. Vitamin B_{12} increased the uptake and retention of the inorganic S^{35} in chicks when fed as a supplement to a simplified ration containing purified soybean protein. The presence of the vitamin as a supplement to a practical type ration decreased the ability of the chick to incorporate inorganic S^{35}. The presence of vitamin B_{12} in the $S^{35}O_4$ dose administered to chicks gave a markedly higher rate of isotope absorption into the blood than the $S^{35}O_4$ alone. (TCO)

19801 MECHENYE BIOLOGICHESKI AKTIVNYE VESHCHESTVA. (Labeled Biologically Active Materials). Moscow, Gosatomizdat, 1962. 96p.

Twenty-one articles are devoted to the preparation of labeled carbon and sulfur compounds used in biochemical studies. (R.V.J.)

Fallout and Ecology

19802 ACTIVITY LOSSES BY EVAPORATION DURING FALLOUT TESTS. Klaus Haberer (Technische Hochschule, Karlsruhe, Ger.). Atomkernenergie, 8: 102-13(Mar. 1963). (In German)

A report is made on the results of investigations for determining the amount of activity losses during the universally used activity measurements in waters, according to the vaporizing method. These results are meant to serve for estimating errors in measurements and to serve perhaps as a basis for methodical improvements of the vaporization method employed by the measuring agencies. Such investigations were previously described in literature only to a very limited extent. The results of these investigations and the work conditions employed by the various measuring agencies during evaporation, which differ considerably from one another in details, are compiled. The influence of various additions, such as acids, complexing agents, and carrier substances, on the activity determination of a fission mixture was investigated, and then the amount of activity losses occurring by adsorption on glass or polyether bottles as well as at higher incandescent temperatures was also determined. On the basis of the test results, a good procedure is described calling for the use of organic acids, preferably citric acid, as an addition for the prevention of adsorption in lieu of the mineral acids used previously. Comparative activity measurements of hard and soft mineral waters to which fission mixtures were added resulted in an empirical correction factor of 1.3 in allowing for activity losses, when this procedure was employed. (auth)

19803 THE MOVEMENT OF O^{15} THROUGH BARLEY AND RICE PLANTS. D. A. Barber (Agricultural Research Council, Wantage, Berks, Eng.), M. Ebert, and N. T. S. Evans. J. Exptl. Botany, 13: 397-403(Oct. 1962).

The shoots of seedling plants were surrounded with O^{15} and the build-up of activity at a point in the roots was recorded. The disappearance of activity on removing the gas from the shoot chamber was followed in the roots at a distance of 15 cm from the seed in 4 varieties of rice, namely Burma, Nachin 57, B. M. 5, and Seraup 50. The diffusion path length was found to be the same for the 4 varieties of rice, and hence the equilibrium radioactivities in the 4 varieties should be proportional to the cross-sectional area of the gas spaces in the roots. The values, expressed as a percentage of the total root cross-section, varied from 5 to 29%. In experiments with barley, only occasionally was it possible to detect any O^{15} moving through the roots. The amount of O^{15} was always too small for the kinetics of the build-up process to be followed. For barley the cross-sectional area of the gas spaces corresponding to the activity in the roots was ~1% of the total root cross-section. The results indicate that the movement of O^{15} through rice and barley plants from the shoot to the root is adequately described by a simple gaseous diffusion process through continuous intercellular spaces. (TCO)

Radiation Effects on Living Tissues

19804 (BNL-6896) EVALUATION OF SPONTANEOUS, CHEMICAL, AND RADIATION-INDUCED MUTATIONS IN THE PINACEAE. François Mergen (Yale Univ., New Haven. School of Forestry and Brookhaven National Lab., Upton, N. Y.). [1963]. Contract AT(30-1)-2755. 34p.

The rate of natural mutation in the Pinaceae can be speeded up by experimental techniques. Results are reported from investigations of the induction of mutations by temperature, chemical agents, ultraviolet and other non-ionizing radiations including ultrasonic waves, and ionizing radiations. Irradiation studies included both the exposure of seed and chronic exposure of entire trees at a low level over a period of several years. It is concluded that artificially induced mutations may contribute greatly to the improvement of trees. (C.H.)

19805 (NP-12691) PRELIMINARY MEASUREMENTS OF THE EFFECT OF Co^{60} γ-RAYS ON THE RESPIRATION RATE OF SHAMOUTI ORANGES AFTER HARVEST. Preliminary Report 396. R. S. Kahan (Israel. Atomic Energy

Commission, Rehovoth); Y. Aharoni, and S. F. Lattar (Israel. National and Univ. Inst. of Agriculture, Rehovoth). Sept. 1962. 6p.

Three experiments were conducted to measure the effect of Co^{60} gamma rays on the post-harvest respiration rate of Shamouti-type Jaffa oranges. Each experiment comprised three groups of 9 specimens, a control group and 2 groups each irradiated with a different dose. The respiration rate of 17° was determined by measuring the weight of oxygen taken up by the group, the measurements being made daily during several days. The fruit in each experiment had received different harvesting treatment. Doses of 93 to 184 krads were employed. In some cases, there was an initial increase in the respiration rate but after a few days, the rate for irradiated fruit approached that of the controls. (auth)

19806 (TID-18510) BONE MARROW PRESERVATION AND TRANSPLANTATION. Progress Report, June 1, 1962–May 31, 1963. (New England Center Hospital, Boston). Apr. 1, 1963. Contract AT(30-1)-2032. 12p.

Six cases of aplastic anemia treated with bone marrow infusions failed to show improvement. This was in contrast to previous apparently good results. Topics discussed include the selection of appropriate homologous donors, the effects of antimetabolites on immune reactions, tissue antigens in blood platelets, graft-host reactions in marrow transplantation, and homologous disease. (C.H.)

19807 (USNRDL-TR-620) GROSS DENTAL LESIONS IN THE RAT INDUCED BY X-RAYS AND NEUTRONS. T. J. Castanera, D. C. Jones, and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Feb. 13, 1963. 27p.

Male Sprague-Dawley rats were exposed at 101 days of age to whole-body doses of 430 or 680 rads of x rays or to 230, 320, or 360 rads of fast neutrons. Dental lesions, evidenced by chalky white zones in the tooth substance, began appearing at the gingival crest approximately 35 days postirradiation in the mandibular incisors and several weeks later in the maxillary incisors. The time of maximum incidence of animals with lesions occurred between the fiftieth and seventy-fifth days postirradiation and, by the end of the fourth month, all lesions had disappeared from the continually growing incisors through attrition at the occlusal edges. The total incidence of animals with one or more lesions was 97% after 430 rads of x ray and 100% after all other doses. The size of the lesions and the number of lesions per animal were greater at the higher doses for each type of radiation. In some animals fractures occurred at the lesion and were confined largely to mandibular incisors. The total incidence of animals with fractured incisors was greater at the higher doses for each type of radiation. Food in meal form, presented in open containers, resulted in a lower incidence of fractures as compared with the results of a previous study in which the same food in pellet form was supplied in wire mesh containers. Neutrons appeared to be two to three times more effective than x rays in producing the lesions. (auth)

19808 (USNRDL-TR-622) MOTOR RESPONSES IN MOTHS TO LOW INTENSITY X-RAY EXPOSURE. J. C. Smith, D. J. Kimeldorf, and E. L. Hunt (Naval Radiological Defense Lab., San Francisco). Feb. 25, 1963. 15p. (AD-401027)

A brief burst of x rays elicited flight activity in the moth when placed in a darkened exposure room. Wing beat activity was recorded as an index of this behavior. Wing beat activity could be initiated in resting moths or amplitude augmented in active moths by x ray dose rates of 0.01 to 1.5 r/sec with a latency of less than 1 sec after onset of exposure. (auth)

19809 (USNRDL-TR-624) BEHAVIORAL AROUSAL AND NEURAL ACTIVATION AS RADIOSENSITIVE REACTIONS. E. L. Hunt and D. J. Kimeldorf (Naval Radiological Defense Lab., San Francisco). Feb. 27, 1963. 56p.

In a study designed to detect prompt reactions to ionizing radiation, rats were exposed to 250 kvp x rays and measurements of behavioral departures from sleep and of heart rate were used to indicate activation of the central nervous system. Exposure at a low dose rate (0.25 r/sec) produced a transitory arousal from sleep within the first 12 seconds (accrued dose of 3 r). At a higher dose rate (1.9 r/sec) this initial reaction increased in scope and, by 30 seconds, included also an acceleration in heart rate. Only animals exposed at the higher dose rate exhibited evidence of excitation during the residual period of exposure to a 1,000 r total dose. Accordingly, the intensity of the reaction during exposure depended upon the dose rate rather than the total dose. A transient excitatory effect at the termination of exposure was indicated by the occurrence of behavioral wakefulness for a period of minutes following exposure at both dose rates. The excitatory effects of irradiation were not dependent upon adrenal function since adrenalectomized animals showed a sequence of reactions comparable to that shown by normal animals but with longer latencies. Stimulation through radiosensitive mechanisms apart from the visual receptor system was indicated since ophthalmectomized animals exhibited both behavioral and heart rate responses within seconds after the start of exposure. Some possible modes for the action of ionizing radiation as a stimulus to the nervous system are discussed. (auth)

19810 (USNRDL-TR-625) DIFFERENTIAL EFFECTS OF SPECIFIC ANTISERA ON THE REJECTION OF ALLOGENIC AND XENOGENIC SKIN GRAFTS BY SUBLETHALLY X-IRRADIATED MICE. M. L. Tyan and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Mar. 4, 1963. 19p. (AD-401541)

Twelve to fourteen week old female LAF_1 mice, nonsensitized or pre-sensitized with two consecutive BALB/c or rat skin grafts, received 670 rad whole-body x radiation and orthotopic tail grafts of LAF_1, BALB/c, C3D/2 and rat skin. Certain groups of mice received specific antisera intraperitoneally, produced in response to BALB/c or rat spleen cells or to two consecutive BALB/c or rat skin grafts. The data indicate that the first-set response to an allogenic skin graft can be significantly inhibited, in sublethally irradiated mice, by specific antisera, while the first-set response to a xenogenic skin graft remains resistant to similar treatment. Specific antisera had no effect upon a pre-existing second-set response. The significance of these data is discussed. (auth)

19811 (USNRDL-TR-627) THE RELATIVE EFFECT OF PULSED RADIATION EXPOSURE IN PRODUCTION OF ACUTE MORTALITY IN MICE. E. J. Ainsworth, G. F. Leong, E. L. Alpen, and K. Kendall (Naval Radiological Defense Lab., San Francisco). Mar. 8, 1963. 25p.

Mice were subjected to pulsed exposures of either fission spectrum neutrons or gamma radiation. The acute mortality response of animals given pulsed radiation of the order of 10^6 rads/min was compared with mortality responses obtained by neutron irradiation at 40 rads/min and gamma irradiation at 100 rads/min. No significant differences in $LD_{50/30}$ were observed as a function of dose rate with either gamma or neutron irradiation. (auth)

19812 (USNRDL-TR-630) MUTUALLY TOLERANT HOST AND DONOR TYPE IMMUNOLOGICALLY COMPETENT CELLS IN MOUSE RADIATION CHIMERAS. W. E. Davis, Jr., M. L. Tyan, and L. J. Cole (Naval Radiological Defense Lab., San Francisco). Mar. 19, 1963. 26p.

Host type immunologically competent cells were found in 4 out of 15 LAF_1 (host)-C3H (donor) long-lived radiation mouse chimeras. Three of these 4 chimeras also had donor type lymphoid cells. Therefore, the host and donor immunocompetent cells must have co-existed in a state of mutual homograft tolerance. Of the remaining 11 chimeras tested, 6 did not exhibit host type immunocompetent cells, while 5 showed questionable host-derived immunological activity. Donor immunocompetent cells were detected in a total of 4 of the 15 LAF_1–C3H chimeras. Host type (i.e., strain A) immunocompetent cells were detected also in two A–LAF_1 radiation chimeras. On the other hand, 10 C3H–$C3D2F_1$ radiation chimeras apparently did not contain host-derived immunogenic cells. The presence of hematopoietic cells of host origin was detected in 4 out of 15 LAF_1–C3H radiation chimeras. Host-derived hematopoietic cells were not detected in the A–LAF_1 radiation chimeras, and only 1 of the 10 C3H–$C3D2F_1$ radiation chimeras had host hematopoietic tissue. Therefore, within the limits of the test system employed the hematopoietic cells in the remaining chimeras must therefore be predominantly of donor origin. (auth)

19813 CYSTOMETRIC EXAMINATION OF PATIENTS TREATED FOR CANCER OF THE UTERINE CERVIX BY IRRADIATION. T. Rautalinko and O. Widholm (Univ. of Helsinki). Acta Obstet. Gynecol. Scand., 40: 403-9(1961). (In English)

The effect of radiation treatment on the capacity and distensibility of the urinary bladder was investigated cystometrically in 68 women who had undergone pelvic irradiation for uterine cancer. All were free of cancer recurrence and were examined <1 yr (Group I), 1-3 yr (Group II), or >3 yr (Group III) later. Cystometry was carried out by filling the bladder with saline and measuring the pressure at which urinary urgency was first felt (M_1) and then became compulsive (M_2). Changes were noted in the cystometrograms after irradiation therapy. Both the M_1 and M_2 values decreased to lower pressures; in addition, the tone of the bladder increased, as shown by the steeper upward sweep of the pressure-volume curve. Furthermore, changes were noted in micturition pressures. The type of bladder function indicated that the changes noted were not individual variations but results of irradiation therapy. The curve of Group III, when compared with that of Group II, was shifted towards the normal curve. This suggests that the change in bladder function caused by irradiation is to some extent reversible. No severely contracted bladders were found. The smallest bladder capacity recorded was 250 ml. Only 1 case of urinary tract infection was found. (TCO)

19814 THE INFLUENCE OF MICROWAVES ON IONIZING RADIATION EXPOSURE. S. M. Michaelson, R. A. E. Thomson, L. T. Odland, and J. W. Howland (Univ. of Rochester, N. Y.). Aerospace Med., 34: 111-15(Feb. 1963).

Results are reported from studies in dogs on the effect of microwave exposure on response to ionizing radiation. Irradiation with 25,000 r resulted in death within 24 hr in 2 of 10 dogs with a previous history of microwave exposure. Nine of 10 normal, irradiated dogs died in the same period. Neurological manifestations were less severe in the microwave-treated dogs. The results suggest that the possibility of using microwave treatment to counteract or minimize the effects of ionizing radiation should be explored. (C.H.)

19815 AGING AND RADIATION. G. J. Neary (Medical Research Council, Harwell, Berks, Eng.). Am. Heart J., 62: 433-5(Oct. 1961).

A discussion is presented of the view that whole-body irradiation of an animal can, in certain circumstances, speed up natural aging. In survival studies of chronically irradiated CBA mice, kept under certain conditions so that external disturbing factors were minimized, mean life shortening of a group of mice is roughly proportional to the mean accumulated radiation dose. Up to ~15 rem/day, there was no reduction in dispersion of survival times even though the mean survival time was nearly halved; the cumulative mortality curves were merely displaced from each other, not contracted; the Gompertz plots were roughly of equal slope. The duration of development was unaffected by radiation and was statistically the same for irradiated and control animals; a value of about 180 days was deduced. The linearity of the dose response is consistent with a cumulative injury due to irreversible changes in cells. The linearity argues against the primary process being one of chromosome structural damage and suggests, rather, somatic gene mutation. The fact that short single doses of x or gamma radiation are ~3 times as efficient as the same doses delivered chronically at low rates indicates a dose-rate factor that is not expected for gene mutation. Moreover, the large size of the doubling dose (thousands of rems) is surprising for a gene mutation unless cell selection for the radiation mutants is much more severe than for the natural mutants. The site of the change may not be in the chromosomes, but a cytoplasmic phenomenon. According to the simplest theory, the life shortening per rem is numerically equal to the ratio of the rate of cell change produced by unit dose rate to the spontaneous rate. (TCO)

19816 ABNORMAL DEVELOPMENT INDUCED BY THE MATERNAL ADMINISTRATION OF PHOSPHORUS-32 AFTER 14 OR 17 DAYS OF GESTATION IN THE RAT. I. SKELETAL DEFECTS. Melvin R. Sikov and James E. Lofstrom (Wayne State Univ., Detroit). Am. J. Anat., 111: 309-17(Nov. 1962).

Pregnant female rats were intraperitoneally injected with graded doses of high specific activity P^{32} in saline after 14 or 17 days of gestation. Control animals were injected with a comparable solution containing stable P. There was a general reduction in the linear dimensions in the various skeletal elements of the more heavily irradiated fetuses. The overall length of the skull was slightly reduced by the administration of 2 mC P^{32} at 14 days of gestation but not by smaller doses. Not even the highest dose (2 mC) injected at 17 days had a substantial effect. Injection of 2 mC at 14 days of gestation produced a marked decrease in skull height, which could be noted as early as 19 days of gestation. Injection of 2.0 mC at 17 days of gestation produced a slight but definite decrease in the skull height at birth, which could be detected at 21 days of gestation. For parietal bone the administration of 2.0 mC at 14 days of gestation again produced the largest effect; femur size and length were decreased. A generalized decrease in the size of the animals was also evident. Qualitative abnormalities were noted in the skeletons. The most prominent was a rib defect, which consisted of a sharp Cephalad angulation at about the dorsal $\frac{1}{3}$ of the posterior several ribs with hyperostosis at the apex of the angle. It was estimated that ~2200 rep are received by the fetal skeleton by the time of birth when 2.0 mC are administered at 14 days of gestation. The average dose-rate to the skeleton is ~0.18 rep/min and after injection at 17 days it approximates 0.41 rep/min. (TCO)

19817 RADIOMIMETIC AGENTS AND X-RAYS IN MICE AND AET PROTECTIVENESS. COMPARATIVE PATHOLOGICAL EFFECTS. M. Asano, T. T. Odell, Jr., T. P. McDonald, and A. C. Upton (Oak Ridge National Lab., Tenn.). Arch. Pathol., 75: 250-63(1963).

The clinicopathological effects of x-rays, mechlorethamine hydrochloride ($HN_2 \cdot HCl$), triethylenemelamine (TEM), busulfan (Myleran), and 4M20 were studied in young adult mice of the RF/Up and (101 X C3H)F_1/Cum strains. The LD_{50}/30 days of these agents were as follows: x rays, 613 r; mechlorethamine hydrochloride, 0.127 mg per mouse; TEM, 0.073 mg per mouse; busulfan, 1.01 mg per mouse; 4M20, 4.41 mg per mouse. The mean time of death varied with the agent and dose; at the LD_{50}/30 day level it was 13.0 days after x rays, 12.4 days after busulfan, 6.9 days after mechlorethamine, 5.9 days after TEM, and 3.5 days after 4M20. The predominant sites of injury varied with the agent as follows: x rays, hematopoietic organs and gonads; busulfan, hematopoietic organs, gastrointestinal tract, gonads; mechlorethamine, brain, hematopoietic organs, gastrointestinal tract, and gonads; TEM, hematopoietic organs, gastrointestinal tract, and gonads; 4M20, liver, hematopoietic organs, and gonads. Injury to the brain by mechlorethamine and to the liver by 4M20 were effects peculiar to these two agents. Pretreatment of the mice with AET reduced the severity of injury to some organs from x rays and mechlorethamine but did not detectably alter the injury resulting from TEM. Paradoxically, AET pretreatment increased the severity of injury by 4M20 in the intestine and bone marrow. (auth)

19818 CONTRIBUTION TO THE PATHOLOGICAL ANATOMY OF PERICARDITIS AND PULMONARY FIBROSIS FROM RADIATIONS IN MAN. Giuseppe Grampa. Atti Accad. Naz. Lincei, Rend., Classe Sci. Fis., Mat. Nat., 32: 245-50(Feb. 1962). (In Italian)

An example of radioinduced pericarditis found in a 71-yr old man exposed to x radiation (3500 r administered in 15 doses) for a suspected pulmonary carcinoma was reported. The medical record, autopsy report, microscopic tests, and anatomic diagnosis for the patient are given. These showed that there was no pulmonary carcinoma, but there was radioinduced pericarditis. (J.S.R.)

19819 EFFECTS OF LOCAL IRRADIATION (Co^{60} TELETHERAPY) ON THE PERIPHERAL BLOOD AND BONE MARROW. F. A. Goswitz, G. A. Andrews, and R. M. Kniseley (Oak Ridge Inst. of Nuclear Studies, Tenn.). Blood, 21: 605-19(May 1963).

Local Co^{60} teletherapy caused a reduction in leukocytes and lymphocytes in the peripheral blood. The bone marrow demonstrated no morphologic change in nonirradiated control sites. Local irradiation produced a pronounced and persistent hypoplasia in the treated sites during and after irradiation, with a great reduction in the numbers of megakaryocytes and precursors of red and white cells. During the period of greatest radiation effect the persistent cells were chiefly plasma cells, mononuclear cells, and lymphocytes. Even after cancerocidal radiotherapy, irradiated bone marrow shows some capacity to regenerate as evidenced by appearance of precursors of various cell series and their ability to incorporate tritium-labeled thymidine. Hemosiderin increased in varying degrees in irradiated sites but showed no change in the control sites. Satisfactory marrow samples can be aspirated from the pubic bone. (auth)

19820 THE SEX-LINKED DRUMSTICK APPENDAGE FREQUENCY AS A MARKER FOR BONE MARROW TRANSPLANTATION IN MONKEYS. E. Magliulo, B. C. Crouch, and M. J. de Vries (Toegepast Natuurwetenschappelijk Onderzoek, Rijswijk, Netherlands). Blood, 21: 620-5(May 1963).

The average values and the range of drumstick counts in the neutrophil granulocytes in males and females of a normal group of rhesus monkeys were estimated. No important individual differences in counting were found between two groups of workers. Irradiation and treatment with autologous bone marrow does not influence the drumstick appendage frequency. The drumstick counts are an important indication of the take of a bone marrow graft when female donors and male hosts are used. (auth)

19821 MEASUREMENT OF BONE MARROW AND GONADAL DOSE FROM X-RAY EXAMINATIONS OF THE PELVIS, HIP, AND SPINE AS A FUNCTION OF FIELD SIZE, TUBE KILOVOLTAGE AND ADDED FILTRATION. Edward R. Epp, Jane M. Heslin, Herbert Weiss, John S. Laughlin, and Robert S. Sherman (Sloan-Kettering Inst. for Cancer Research, New York and Memorial Hospital for Cancer and Allied Diseases, New York). Brit. J. Radiol., 36: 247-65(Apr. 1963).

Detailed measurements were made of the dose absorbed by the bone marrow and by the reproductive organs of a realistic human phantom exposed to anteroposterior and lateral radiographic examinations of the pelvis, lumbar spine, thoracic spine, and cervical spine, and to the anteroposterior examination of the hip. The measurements were made over a range of parameters including kilovoltage, filtration, and useful beam size. The kilovoltage range extended, for most of the examinations, from 60 to 110 Kvp. The effect of added filtrations of 1 and 2 mm Al was determined for most cases. In general, measurements were made for two x-ray field arrangements. Arrangement A, provided by a well-shielded collimator, yielded a field just large enough to cover the film of interest. Arrangement B was provided by a conventional radiographic cone yielding a field usually considerably larger than the film. The method of measurement involved the use of small ionization chambers which exhibited a high degree of energy, directional and dose-rate independence in the diagnostic x-ray energy region. The results are expressed in units of dose per Mas of x-ray machine exposure. Expressed in this way, these measured ratios are independent of the kind of film used, the type of cassette, screen, or Bucky used, and of the subjectivity involved in determining the Mas exposure required to obtain a satisfactory radiograph. The values of these ratios can be applied to any particular choice of the above variables. The measured values of marrow exposure dose at representative sites were weighted in accordance with the fractional distribution of active marrow to yield the average active marrow absorbed dose per unit of Mas exposure. Complete tables of the measurements are given. By interpolation estimates of bone marrow and gonadal exposure can be made for any procedure using parameters within the range studied. (auth)

19822 SOME FACTORS INFLUENCING THE EXPERIMENTAL DETERMINATION OF PERCENTAGE DEPTH DOSES FOR MEDIUM ENERGY X RAYS. R. G. Wood (Cardiff Radiotherapy Centre, Whitchurch, Eng.), W. H. Sutherland, and M. Cohen. Brit. J. Radiol., 36: 266-73(Apr. 1963).

The effects of a number of variables on the experimental determination of percentage depth doses for medium energy x rays are discussed, including chamber size, type of

applicator, and method of extrapolation to surface dose-rate. A method of transformation for converting depth doses for a diaphragm-limited-field to those for a closed-ended applicator is also discussed. (auth)

19823 THE EFFECT OF RADIOACTIVE PHOSPHORUS ON THE GROWTH AND DEVELOPMENT OF CULEX PIPIENS MOLESTUS FORSK. Albert A. Abdel-Malek (Cairo Univ.). Bull. Entomol. Res., 52: 701-8(Dec. 1961).

Radioactive larvae, pupae, and adults were produced by adding $Na_2HP^{32}O_4$ to the larval rearing medium, consisting of tap water and dog food pellets. For all initial concentrations of P^{32} in the larval medium, the larger the larva, the greater the uptake of P^{32}. At an initial concentration of 10.0 μC of P^{32} per ml, about half of the larvae died within 10 days. P^{32} had little noticeable effect on larval growth up to a concentration of 3.0 μC/ml; above this concentration, growth was greatly retarded. Pupation by larvae in media having a P^{32} concentration 1.0 μC/ml was prolonged to over 5 weeks, and at concentrations of 3.0 and 5.0 μC/ml, only a small percentage of the larvae initially introduced into the media pupated. At P^{32} concentrations of 5.0 μC/ml or higher, no adults emerged. However, at 1.0 μC/ml, the next lower concentration tested, 50% of the treated individuals emerged. It is suggested that, for efficient utilization of P^{32} in large-scale field experiments, a concentration of 1.0 μC/ml would be needed to produce adult mosquitos sufficiently radioactive to be readily detectable by a scaler or survey meter. It was concluded that radiation may affect growth and development of mosquitoes by disruption of enzyme systems and inhibition of various processes necessary for pupal differentiation. (TCO)

19824 A COMPARATIVE ANALYSIS OF TROPHIC DISORDERS CAUSED EITHER BY DENERVATION OR BY SINGLE LOCAL IRRADIATION OF AN INTACT OR DENERVATED EXTREMITY IN RABBITS. M. N. Livanov, L. M. Khanina, and Yu. A. Kholodov. Byul. Eksperim. Biol. i Med., 54: No. 9, 42-6(1962).

A denervated extremity in 10 rabbits was irradiated with 5000 r x rays. In 8 control rabbits an intact extremity was similarly irradiated and in another 7 rabbits an extremity was denervated only. Denervation was achieved by injecting a mixture of 5 ml of 0.5% novocain solution and 5 ml of 96% alcohol into the sciatic nerve and 10 ml of novocain into the muscle tendon sheath. Irradiation of a denervated extremity did not develop dystrophic processes. Trophic disorders following irradiation resulted from damage to the innervation caused by the ionizing radiation. The appearance of ulcers on the contralateral extremity indicated that the irradiation effect is due to its denervating activity and to another mechanism associated with reflex phenomena. (OTS)

19825 LEUCOCYTIC RESPONSE TO HETEROLOGOUS BLOOD TRANSFUSION IN IRRADIATED RATS. R. F. Yurin. Byul. Eksperim. Biol. i Med., 54: No. 9, 58-62 (1962).

Experiments were carried out on 52 female rats weighing 156 to 310 g. The whole-body irradiation dose was 450 r ($LD_{50/30}$) and the dose rate 59 r/min. Heparinized blood from a dog (0.1 mg of heparin/1 ml blood) was used for transfusion. The transfusion rate was 0.1 ml/sec and the dose 2 ml/100 g body weight. The blood for analysis was obtained from the caudal vein 54 to 56 min before, and 1-, 2-, 3-, and 6-hr after transfusion, performed 6 hr, 3 days, and 4 and 8 weeks after irradiation. It was found that the leukocytic response to heterologous blood transfusion was preserved also after irradiation, despite the presence of severe disorders in leukopoiesis, resulting from acute radiation sickness. (OTS)

19826 THE STIMULATING EFFECT OF A COMBINED IMMUNIZATION OF BCG VACCINE AND OTHER VACCINES ON IMMUNOGENESIS IN IRRADIATED AND NON-IRRADIATED MICE. N. N. Klemparskaya and G. A. Shal'nova. Byul. Eksperim. Biol. i Med., 54: No. 9, 78-81(1962).

Experiments were carried out on 1474 albino female mice weighing 18 to 20 g, inoculated with a living B. coli culture injected subcutaneously (s.c.) into 220 mice (25 or 100 millions of microorganisms); a monovaccine of B. paratyphi Breslau No. 2503 killed at 56 to 58°C, injected intracutaneously into 439 mice (200 millions); a tetravaccine against typhoid, B. paratyphi B, S. flexneri, and S. sonnei, injected s.c. at a dose of 0.25 ml into 760 mice. The dry BCG vaccine was added (1 mg/0.1 ml solution) to the vaccines immediately before injection in its native form or after autoclaving. Whole-body irradiation was carried out on groups of 12 mice with a 300 r dose at a dose rate of 20 to 22 r/min. Immunity was tested by inoculation with living bacterial cultures. It was found that the addition of BCG vaccine as an adjuvant to other vaccines increased markedly the immunity of both nonirradiated and irradiated mice. The discovery has theoretical and practical importance. (OTS)

19827 STUDY OF LOCAL RADIATION INJURIES IN DNA BY THERMAL SEPARATION OF THE DOUBLE HELIX. N. I. Ryabchenko, P. I. Tseitlin and A. G. Yaskevich. Byul. Eksperim. Biol. i Med., No. 11, 51-4(1962).

The effect of irradiations on DNA macromolecule was studied on the basis of the degradation kinetics and viscosity of its one-strand structures. A double-helix DNA ($N/P \cong 1.64$ to 1.68; E(P) = 6500 to 6700; molecular weight = 7×10^6 to 8.5×10^6) was obtained from calf thymus and x irradiated with 5000 r/min. Uv irradiation lasted for 5 min, dose 4.7×10^4 erg/min/mm^2. One-strand DNA was obtained at 88°C. The number of strands was calculated from log η/log R divided by $-\alpha$, where η is the viscosity, R the x-ray dose in r, and α the exponent in the Staudinger equation. Since the number of chains, n, was ~1 in irradiated and nonirradiated structures, it was assumed that x irradiation does not cause thermostable crosslinking. Uv irradiation inhibited the separation of the strands, owing to crosslinking. The results agree closely with viscosity data obtained with different electrolytes and temperatures. When the Na^+ ion concentration was increased from 0.01 to 0.2 M, the one-strand DNA from irradiated as well as nonirradiated DNA coiled up, and the viscosity decreased by 20 to 30 times. When the temperature in 0.2 M Na^+ was raised from 25 to 70°C, the viscosity increased by a factor of 3.0 to 3.7. The viscosity of the irradiated one-strand DNA was, however, only 1/3 to 1/4 that of the nonirradiated; this is apparently due to solitary breaks in the chains. The effects of increased temperature and ion concentration in uv-irradiated one-strand DNA were much less marked. (OTS)

19828 CHANGE IN EFFECT OF EPINEPHRINE AND NOREPINEPHRINE ON BLOOD PRESSURE IN IRRADIATED ANIMALS. V. Grossmann, H. Dyntarova, J. Slaho, and J. Kornova (Charles Univ., Prague). Casopis Lekaru Ceskych, 102: 169-72(Feb. 15, 1963).

The effects of epinephrine and norepinephrine on blood pressure in rats and mice exposed to 600 r and rabbits exposed to 1000 r were studied. Intravenous toxicity increased and blood pressure effects in anesthesia decreased (with epinephrine, no decrease at very high doses). No change in

effects on the isolated heart was noted. It was speculated that changes were of central origin, possibly also due to increased epinephrine sensitivity of the heart. (P.C.H.)

19829 EFFECT OF RADIOACTIVE ISOTOPES ON THE ELECTROENCEPHALOGRAM. V. Kvicala and J. Stein (Charles Univ., Prague). Cesk. Neurol., 26(59): 27-32 (Jan. 1963).

EEG studies were made before and 24 and 48 hours after administration of diagnostic doses of I^{131}. In 5 patients, the EEG was worse, in 2 (pituitary adenoma, metastatic tumor of posterior fossa) there was marked improvement. It was concluded that I^{131} does not affect the EEG. (P.C.H.)

19830 A SIMPLE AND EFFICIENT METHOD FOR ^{131}I LABELLING OF INSULIN AND GLUCAGON. J. J. Haxhe and P. J. Kestens (Lab. of Experimental Surgery, Louvain, Belg.). Clin. Chim. Acta, 8: 302-5(Mar. 1963). (In English)

Procedures are described for labeling insulin and glucagon with I^{131}. The resulting preparations have a high specific activity. (C.H.)

19831 DELAYED INTERVENTION OF DNA DURING RESTORATION OF A RADIOLESION. Jean Loiseleur, Liliane Catinot, and Annick de Vomécourt. Compt. Rend., 256: 1160-1(Jan. 28, 1963). (In French)

After a latency of ten days following localized cutaneous irradiation causing necrosis, the rate of DNA increases in all nonirradiated homologous tissue. Local irradiation therefore exercises a general effect on the skin in its entirety. (tr-auth)

19832 STABILITY OF DNA AFTER RADIOVACCINATION AND SEROTHERAPEUTIC TREATMENT OF CUTANEOUS RADIOLESIONS. Jean Loiseleur, Liliane Catinot, and Annick de Vomecourt. Compt. Rend., 256: 1637-8(Feb. 11, 1963). (In French)

The treatment of cutaneous radiolesions in the rat by vaccination or by serotherapy causes an identical stabilization of radiolesions and of DNA. This similitude permits these results to be attributed to the intervention of the same restoration factor which appears in the serum of the animal vaccinated and which preserves its properties when this serum is injected in any animal undergoing a cutaneous irradiation. (tr-auth)

19833 EFFECT OF X-RAYS ON MEIOSIS OF L. PERUVIANUM (MILL.). R. Georgieva and E. Molhova. Compt. Rend. Acad. Bulgare Sci., 15: 651-4(1962).

It was found that the optimal doses for obtaining modified forms of L. esculentum are 12000 and 15000 r; seeds radiated with 30000 r produced modified forms. Experiments to fertilize individual plants with normal L. peruvianum or L. esculentum failed. (OTS)

19834 PROGNOSTIC CONSIDERATION OF CHANGES OF PERIPHERAL BLOOD STRUCTURE IN GUINEA-PIGS EFFECTED BY INTENSIVE RADIATION. D. Zographov. Compt. Rend. Acad. Bulgare Sci., 15: 655-8(1962).

A comparative study of the effects of radiation (300 r) on peripheral blood changes was conducted with a number of guinea pigs. The results were compiled in groups in accordance with life-span periods. (OTS)

19835 DIABETES MELLITUS IN HIROSHIMA, JAPAN. A DETECTION PROGRAM AND CLINICAL SURVEY. Paul A. Rudnick and Paul S. Anderson, Jr. (Atomic Bomb Casualty Commission, Hiroshima-Nagasaki). Diabetes, 11: 533-43(Nov.-Dec. 1962).

Available data prove that diabetes is not uncommon in Japan. In an adult study population in Hiroshima the prevalence rate was 3.02 per cent. Nearly one half of the patients were diagnosed initially as a result of the detection program. Although in females a trend with radiation exposure was suggested by the raw data, no statistically significant differences could be demonstrated. Clinical and laboratory studies were performed for 108 diabetic subjects. Although late manifestations of diabetes frequently were found, atherosclerotic complications were nonexistent. This is considered to be related to the low fat, high carbohydrate diet of the Japanese. The lack of ketosis, apparently low prevalence rate for juveniles, and male preponderance suggest that diabetes in Japan differs from the disease found in many Western countries. (auth)

19836 SENSITIZATION OF TUMOR CELLS TO THE EFFECT OF IONIZING RADIATIONS BY INHIBITORS OF RADICAL REACTIONS. G. G. Afanasiev, L. P. Lipchina, and I. I. Pelevina. Dokl. Akad. Nauk SSSR, 148: 1199-1201 (Feb. 11, 1963). (In Russian)

Compounds that act as inhibitors of radical reactions were shown to increase the sensitivity of mice tumor cells to ionizing radiation. In in vitro experiments on Ehrlich ascites tumor, with propyl gallate as the sensitizer, 17% aberration was obtained, as opposed to 9% in the controls; with 800 r irradiation by gamma rays, 41.4%; and with 800 r 15 min after addition of propyl gallate to the ascitic fluid, 97.7%. In in vivo experiments, mice were given 4(N,N-di-(β-oxyethyl)-aminomethyl)-1,2-ditertbutyl phenol 45 min before irradiation. Intramuscularly administered inhibitor did not show sensitization effects, but intraperitoneally administered inhibitor followed by 400 r irradiation showed synergistic action. Data are given for 24, 48, and 72 hr after irradiation. (TTT)

19837 FREQUENCY OF OCCURRENCE OF LEUKOSES IN SINGLE AND REPEATED IRRADIATIONS. S. N. Aleksandrov and K. F. Galkovskaya. Dokl. Akad. Nauk SSSR, 149: 194-7(Mar. 1, 1963). (In Russian)

Mice were irradiated (Co^{60} source) in a study of the dependence of the frequency of occurrence of irradiation-induced leukemia on the irradiation conditions. Various organs of controls and of animals given 800 r in a single dose and in 200-r doses repeated at 7-day intervals and at 30-day intervals were examined. In the irradiated animals there were 131 cases of leukemia, 86% being myeloid and 14% lymphoid. This ratio is similar to that found in the human. Morphologically, both the myeloid and lymphoid had the appearance of acute processes; histologically chronic leukemia appeared to take on an acute nature in terminal stages. There were no leukoses in the controls. The frequency of leukoses in singly irradiated animals was similar to that in the animals irradiated at 7-day intervals except that in the latter group the females showed a somewhat higher frequency. Both males and females in the 30-day-interval series showed a sharply increased rate. (TTT)

19838 THE INDUCTION OF DOMINANT LETHAL MUTATIONS IN X-IRRADIATED DROSOPHILA VIRILIS OOCYTES. Richard C. Dickerman (Univ. of Texas, Austin). Genetics, 48: 311-19(Mar. 1963).

Two stages of Drosophila virilis oocytes were used to study the induction of dominant lethal mutations: Stage 7, which is the most developed oocyte in newly emerged flies, and Stage 14, which is the mature oocyte and is present in females which have been held as virgins for five days. Stages 7 and 14 oocytes x irradiated in conditions of increased oxygen tension showed an increased frequency of dominant lethals when compared to oocytes irradiated in

one atmosphere of air. Oocytes irradiated in the presence of nine atmospheres of argon, helium, or methane with one atmosphere of oxygen showed a large decrease in induced dominant lethals when compared to oocytes irradiated in one atmosphere of oxygen. This demonstrates that argon, helium, and methane have a protective effect against the induction of dominant lethal mutations. Stages 7 or 14 oocytes irradiated in the absence of oxygen showed a large decrease in the induction of dominant lethal mutations when compared to oocytes irradiated in one atmosphere of air, thus indicating that decreased oxygen in the system leads to decreased damage to the oocyte. In contrast to results in males, no increase in damage is observed in Stage 7 oocytes irradiated in one or ten atmospheres of carbon monoxide. In Stage 14 oocytes irradiated in one or ten atmospheres of carbon monoxide there is much less damage than oocytes irradiated in air, but slightly more damage than oocytes irradiated in helium, methane, or argon. (auth)

19839 COINCIDENCE RELATIONS BETWEEN GENE CONVERSION AND MITOTIC RECOMBINATION IN SACCHAROMYCES. S. Fogel and D. D. Hurst (Brooklyn Coll., N. Y.). Genetics, 48: 321-8(Mar. 1963).

A diploid clone of Saccharomyces, in which both heteroallelic repair and mitotic recombination could be observed, was treated with ultraviolet light, plated on a complete nonselective medium, and scored for both classes of recombinational events during mitosis. An increase in both types of events with increased radiation dose was observed. A coincidence of mitotic recombinants or recessive marker homozygosis in excess of expectations due to independence was found in the convertant population. It is suggested that reciprocal and nonreciprocal mitotic recombination have a common precursor condition for their expression. (auth)

19840 CHARACTERISTICS OF OFFSPRING FROM TEN GENERATIONS OF X-IRRADIATED MALE MICE. J. F. Spalding, V. G. Strang, and W. L. LeStourgeon (Los Alamos Scientific Lab., N. Mex.). Genetics, 48: 341-6(Mar. 1963).

Breeding characteristics, as measured by litter data comparisons, of offspring of ten generations of x-irradiated sires were studied. Irradiated-line mice were found to be less efficient breeders than were control-line mice. The inheritance of radiation-induced deleterious recessive mutants and of lethal mutations was indicated. (auth)

19841 THE ORIENTATION OF MULTIPLE ASSOCIATIONS RESULTING FROM INTERCHANGE HETEROZYGOSITY. C. W. Lawrence (Atomic Energy Research Establishment, Wantage, Berks, Eng.). Genetics, 48: 347-50(Mar. 1963).

Among the many factors thought to influence the orientation associations in interchange heterozygotes, previous evidence suggests that there is a genetically controlled mechanism (or mechanisms) which is distinct from that varying the position and number of chiasmata. In rye, variation between 50% and 90% disjunction frequency has been ascribed to this mechanism. Nevertheless, in this species, directed segregation has been found in newly arising interchanges, suggesting that the genetic constitution has been selected to give a high disjunction frequency. Two alternative explanations for these findings were considered. First, the influence on orientation may be a secondary effect of factors whose primary effect is of selective importance in normal, non-interchange individuals. Second, direct selection for a high disjunction frequency may have occurred in a manner analogous to Fisher's theory of the evolution of dominance. (auth)

19842 URINARY BLADDER COMPLICATIONS AFTER RADIOTHERAPY OF UTERINE CERVICAL CARCINOMA. D. Papademetriou. Hellen. Cheir., 9: 125-38(1962).

19843 STUDY OF THE ANTIGENIC CONSTITUENTS OF SERUMS FROM MOUSE/RAT CHIMERAS. P. Grabar, J. Courcon, D. W. H. Barnes, C. E. Ford, and H. S. Micklem (Medical Research Council, Harwell, Berks, Eng.). Immunology, 5: 673-86(Nov. 1962).

The serums of CBA mice lethally irradiated (1000 r whole-body x irradiation) and restored with rat bone marrow or fetal liver were examined by immunoelectrophoresis at various times after irradiation. Several specific rat proteins including γ globulin, at least 2 α_2-globulins, 1 or 2 β_1-globulins, and 1 β_2-globulin were found. A large number of specific mouse proteins were also present, but no mouse γ-globulins were detected. The rat constituents appear progressively and persist for long periods, indicating that they are synthesized by rat cells. There is a close correlation between the presence of rat γ-globulin in the serum and the presence of dividing rat cells in the bone marrow and spleen. The fact that γ-globulin is solely of rat specificity does not necessarily rule out the possibility of immune activity by the host against the graft. Several of the normal serum proteins, in addition to the γ-globulins, originate from the injected cells, and are therefore presumably not synthesized by the liver. In chimeras grafted with rat skin, the number of specific rat serum proteins is often larger than in chimeras that have not been grafted. There was no evidence that γ-globulins of mouse specificity were being synthesized in the chimeras although they might be present in amounts below the sensitivity of the method. Presumably, mouse cells capable of synthesizing γ-globulins were totally destroyed by irradiation. (H.H.D.)

19844 ULTIMATE MAXIMUM VALUES OF THE RBE OF FAST NEUTRONS AND GAMMA-RAYS FOR CHROMOSOME ABERRATIONS. G. J. Neary, J. R. K. Savage, H. J. Evans, and J. Whittle (Medical Research Council, Harwell, Berks, Eng.). Intern. J. Radiation Biol., 6: 127-36(Feb. 1963). (In English)

If for some radiobiological effect the form of the dose-response is different for two radiations, the value of the RBE will vary with the dose, and a single value at just one level of effect will by itself alone convey little information. If, however, a linear term were present in the dose-response, it would predominate at low doses or long exposure times and then the RBE of two radiations would approach a constant limit. This situation was investigated for chromosome aberrations in Tradescantia microspores produced by short and long exposures to fast neutrons and gamma-rays. The data indicate that at low doses or long exposure times the RBE of the fast neutrons is high and must approach values of the order of 100. (auth)

19845 OBSERVATIONS ON X-RAY-INDUCED RADICALS IN WHOLE BACTERIOPHAGE AND PHAGE NUCLEIC ACID. Adolf Mueller (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 6: 137-42(Feb. 1963). (In English)

Electron-spin-resonance (ESR) measurements on x-rayed purified bacteriophage of E. coli T2 and on DNA extracted from this phage yielded the following main results: The ESR absorption of DNA irradiated in vacuo at various temperatures showed a pronounced hyperfine structure if measured in vacuo at room temperature. When DNA is subjected to increasing doses of x rays in vacuo at room temperature saturation of radical concentration occurs at a few hundred kr. The initial energy expenditure measured at room tem-

perature after irradiation at various temperatures ranges between 8 and 30 ev per radical induced. The ESR absorption of whole phage irradiated in vacuo at various temperatures is at room temperature equal to the absorption of phage-DNA plus that of a similar quantity of protein. The dependence of radical concentration on dose in whole phage irradiated in vacuo at room temperature is equal to the dose-dependence of DNA, plus that of a similar quantity of protein. (auth)

19846 TEMPORARY RADIOSTABILITY IN EXTRACELLULAR BACTERIOPHAGES AFTER TRAPPING OF MOLECULES OF THE CYSTEINE-CYSTEAMINE GROUP. Gerhart Hotz (Kernforschungszentrum, Karlsruhe, Ger.). Intern. J. Radiation Biol., 6: 143-9(Feb. 1963). (In English)

Ten different strains of bacteriophages were checked for a new phenomenon tentatively designated as phage-SH complex. The phages were incubated in nutrient broth solution to which 0.5 M cysteine or cysteamine was added. The x irradiation, however, was performed with the phages in an anoxic medium in which the sulphydryl concentration was reduced below that concentration sufficient for protection. It was observed that some phages are able to acquire a temporary radioresistance. The effect of oxygen and of an SH-blocking compound on the phage-SH complex was investigated and related to phage structure. The protective mechanism is discussed in the light of current hypotheses. (auth)

19847 STUDIES ON THE INCORPORATION OF TRITIATED THYMIDINE IN DESOXYRIBONUCLEIC ACID IN MOUSE TISSUES AND ON ITS RADIATION EFFECTS. Karen Halvorsen Garder (Institutt for Atomenergi, Kjeller pr. Lillestrøm, Norway) and Finn Devik. Intern. J. Radiation Biol., 6: 157-72(Feb. 1963). (In English)

Studies are reported which were designed to check for possible disadvantageous effects of labeling DNA with tritiated thymidine of high specific activity in long-term experiments. Three series of mice were injected with 200 μc, 20 μc, and 5 μc of the substance per mouse, and one series received 4 μc per mouse of C^{14}-labeled thymidine. The total activity was recorded, and the degree of labeling was investigated in autoradiographs at intervals up to 120 days after injection in seven different tissues. The results indicate that cellular death due to radiation from the label occurs in mice labeled with a dose of 200 μc, and possibly also with a dose of 20 μc per mouse (about 1 μc/g). The incorporation of thymidine in several tissues does not increase proportionately to the amount available, indicating a pool effect that might be due to thymidine existing as a normal intermediate. The findings may have implications for the use of tritiated thymidine as a label for DNA in autoradiographic studies. (auth)

19848 VARIATIONS IN THE BLOOD-CONTENT OF $^{90}Sr/^{90}Y$ OF MICE INJECTED AFTER A 200 r WHOLE-BODY X-RAY DOSE. Bo Holmberg (Cancer Research Div. of Radiumhemmet, Stockholm), Monica Dahlstrom, and Elsie Wallgren. Intern. J. Radiation Biol., 6: 181-6(Feb. 1963). (In English)

Male albino mice were given a whole-body roentgen dose of 200 r and were then intraperitoneally injected at various intervals with 4 μc Sr^{90}. The animals were killed at various times after the injections, and the Sr^{90}/Y^{90} content of whole blood was estimated. Non-irradiated mice were used as controls. The values of Sr^{90} obtained agree with a theoretical equation expressing the overall state of isotope in blood after an intraperitoneal injection. The constants for the two interacting processes, r for inflow and q for outflow of isotope in the blood, are increased in irradiated animals as compared with controls. This indicates an injury to the transport routes of injected isotope to and from the blood system, induced by a 200 r whole-body dose. This injurious effect of x rays can be demonstrated as early as 5 min after the roentgen treatment. (auth)

19849 METHOD OF DETERMINING RADIATION DOSAGE BY MONITORING DENTAL GOLD RESTORATIONS. Jack L. Hartley (Providence Hospital, Portland, Ore.), Robert W. Zellmer, Everett O. Richey, and Norman O. Harris. J. Am. Dental Assoc., 65: 746-50(Dec. 1962).

An experiment was conducted to determine whether there was a direct correlation of total neutron dose to the neutron activation of dental Au alloy restorations. To test the hypothesis, Au inlays (equal in volume to the cubes used in the reactor experiment) were placed in the second deciduous molars of 10 young monkeys, which were subsequently exposed to radiation at various distances to nuclear explosions. The measured activities of the Au samples were corrected by standard methods for resolving time, geometry, counting efficiency, and decay time. The resulting activities for each sample at the time of exposure were then adjusted for the amount of Au per sample and the activity expressed as disintegrations/min/g Au. The activities of all the samples in each group were combined to obtain the mean activity/g Au at each position. The mean induced activity of the Au for each group of animals was proportional to the neutron dose in rads as measured by the Hurst fission foil technic. The mean neutron dose varied from 374 to 485 rad, resulting in induced activities of the Au varying from 1.16 to 1.94×10^7 disintegrations/min/g. Histopathologically, no significant differences from the normal were found. It was concluded that the activity of the Au restorations can be used to calculate the extent of neutron flux after a nuclear accident. This can be accomplished immediately after exposure, whereas other tissue changes and resulting clinical symptomatology do not become apparent for some time. (TCO)

19850 THE RELATION OF DEVELOPMENTAL STATUS OF LIMB FORMATION TO X-RADIATION SENSITIVITY IN CHICK EMBRYOS. I. GROSS STUDY. Richard A. Goff (Oak Ridge National Lab., Tenn. and Univ. of Oklahoma, Norman). J. Exptl. Zool., 151: 177-200(Nov. 1962).

A closely graded series of chick embryos in stages 8 to 35 were x irradiated with doses selected so that the lethal effects at different stages were approximately equal. The type of skeletal anomaly induced in the limbs depended on the developmental status at the time of irradiation. The pattern of radiosensitivity is intimately related to the developmental progression. The gross picture emerging is that, following x irradiation, the early disto-proximal gradient of reduction in size correlates with the rapid lateral expansion of the limb primordia. Specific reduction after limb emergence is induced by radiation when, it is presumed, the early regional proliferation of a dense blastema is occurring. The fusion phenomenon is induced when the skeletal elements consist of a dense mesenchymal blastema or early pre-cartilage. (auth)

19851 COMPARATIVE RADIOSENSITIVITY OF FORELIMB AND HINDLIMB PRIMORDIA IN AMBLYSTOMA PUNCTATUM. Jean Piatt (Univ. of Pennsylvania, Philadelphia). J. Exptl. Zool., 150: 143-9(July 1962).

Embryos at stage 34, the earliest at which hindlimb rudiments can be located, were irradiated with 240-kv x rays at a rate of 152 r/min. The exposure dose was 1000 r and the absorbed dose estimated to be 950 rad. Within 10 to 90

min after irradiation, forelimb and hindlimb primordia were transplanted orthotopically to nonirradiated embryos of the same age. Both the irradiated and nonirradiated control grafts were examined daily for a period of 40 days. Development of the irradiated forelimb grafts was normal through stage 39. From this time until well past stage 46 all of the grafts were retarded in their differentiation and a large number of them became abnormally differentiated as early as stage 45. Development of the irradiated hindlimb grafts was normal in almost $1/4$ of the cases from the earliest appearance of the limb bud. About $3/4$ were either retarded or not yet formed during the earliest stages of development. At the same embryonic age the more mature forelimb rudiment is more radiosensitive than is the less mature hindlimb rudiment. The results suggest that radiosensitivity of an embryonic structure is not necessarily a function of chronological age but of respective levels of differentiation. (TCO)

19852 EFFECTS OF REPETITIOUS WORK ON PERFORMANCE OF NORMAL AND IRRADIATED MONKEYS. A. A. McDowell and W. Lynn Brown (Univ. of Texas, Austin). J. Genet. Psychol., 101: 15-19(Sept. 1962).

Monkeys were each irradiated with both gamma rays and neutrons, at doses varying from 70 to 557 r plus 10 to 54 rep, respectively. Irradiation preceded testing by ~4 yr. Tests were conducted in a modified version of the Wisconsin General Test Apparatus, the stimulus objects being a red-painted triangular wood block and a red-painted circular wood block mounted vertically on red-painted rectangular wood blocks. Each monkey was tested for 50 trials or until balking occurred each day for 44 days on the same form-discrimination problem. Response to the red triangular block was consistently rewarded; response to the red circular block was consistently nonrewarded. The findings support the hypothesis of greater work decrement for normal than for previously irradiated monkeys under conditions of repetitious work. The decrement was manifested as refusal to respond. The results are interpreted as suggesting response competition for the normal monkeys between the stimuli of the test situation and stimulus features of the test situation extraneous to the solution of the experimenter-defined problem. (TCO)

19853 EFFECT OF ERYTHROPOIETIN ON TRITIATED THYMIDINE INCORPORATION BY THE RAT SPLEEN. Efstratios S. Kurtides, Walter A. Rambach, Howard L. Alt, and John C. Wurster (Northwestern Univ., Chicago). J. Lab. Clin. Med., 61: 23-33(1963).

The action of erythropoiesis-stimulating factor (ESF, erythropoietin) obtained from the plasma of anemic rabbits was demonstrated by measuring the uptake of H^3-labeled thymidine by rat spleen. The splenic incorporation of thymidine in ESF-stimulated animals was significantly elevated over control values at all time intervals studied (15 to 180 min). Maximum labeling occurred at 60 min, with the 180-min values being essentially equal to those obtained at 60 min. The values reflect tissue proliferative activity since under the stimulus of ESF, thymidine uptake is increased by a factor of 4. The 60-min values most directly reflect DNA incorporation of label and indicate the DNA synthetic capacity of tissues. In order to study the effect of ESF on cells of the reticuloendothelial system (RES) in spleen, the animals were made hypoxic (maintained in a 7.7% O atmosphere) and irradiated (800 r, whole-body 220-kv x rays). Acute hypoxia was shown to protect against x radiation. Although the absolute number of splenic RES cells was not increased by irradiation, their relative counts in spleen increased 5-fold 96 hr after irradiation. Spleen weight decreased 36 to 46% and was not affected by injection of ESF. Body weight and hematocrit remained normal but circulating reticulocyte count fell after irradiation and was not restored by ESF. ESF injection also failed to stimulate the incorporation of thymidine-H^3 in RES cells, indicating its selective effect on hemopoietic cells. (H.H.D.)

19854 ORGAN DISTRIBUTION OF FIBRINOLYTIC ACTIVITY IN MAN. Herschel Sandberg, Mohammed Rezai, Teofilo T. Bangayan, Samuel Bellet, Leonard J. Feinberg, and Sandra Hunter (Philadelphia General Hospital). J. Lab. Clin. Med., 61: 592-603(Apr. 1963).

In necropsy samples of lung taken from 2 patients who had undergone radiotherapy for metastatic cancer, irradiated portions of lung showed much higher fibrinolytic activity than nonirradiated areas. Lung generally showed weaker fibrinolytic activity than most other organs. The finding of increased activity in irradiated human tissue is in agreement with the rise in activity previously found in irradiated animals. (H.H.D.)

19855 SOME S-SUBSTITUTED DERIVATIVES OF 2-AMINOETHANETHIOL. Thomas P. Johnston and Anne Gallagher (Southern Research Inst., Birmingham, Ala.). J. Org. Chem., 26: 3780-83(1961).

Several new S-substituted derivatives of 2-aminoethanethiol hydrobromide were prepared for testing as antiradiation drugs; the preferred procedure involved the aminoethylation of an appropriate sulfur-containing anion in N,N-dimethyl formamide. The oxidation of 2-aminoethanethiol hydrochloride through the action of trichloromethanesulfenyl chloride described as a simple and convenient method applicable to the preparation of large amounts of 2,2′-dithiobisethylamine (cystamine) dihydrochloride. (auth)

19856 A NOTE ON IRRADIATED HEPARIN: SOME BIOLOGICAL AND CHEMICAL PROPERTIES. S. S. Adams, B. V. Heathcote, and P. E. Macey (Boots Pure Drug Co. Ltd., Nottingham, Eng.). J. Pharm. Pharmacol., 13: 240-3(Apr. 1961).

The effect of γ radiation and high-energy electrons on the anticoagulant and antilipemic properties of heparin was investigated. Purified sodium heparin and a 25% solution of sodium heparin in distilled water were irradiated by a 100-C Co^{60} source or high-energy electrons. The γ radiation dose rates were about 1000 rad/min; the electron dose rates were about 3 Mrad/min. There was a fall in both activities, but the anticoagulant action was reduced more readily than the antilipemic. After electron bombardment the anticoagulant activities of 2 different batches of heparin were reduced almost identically. The loss of activity was greatest in the heparin solutions and lowest in dried heparin that contained only 1% moisture. There was some evidence that irradiated samples showed instability since a fall in anticoagulant activity was noted on prolonged storage. A fall in the biological activity was accompanied by a fall in pH of the samples and an increase in reducing power. A decrease in the metachromatic reaction of heparin also occurred but was less marked than expected and indicates that the measurement of metachromasia bears little relation to biological activity. Thus heparin retaining only 10% of its anticoagulant activity nevertheless produced a fairly strong metachromatic reaction. (H.H.D.)

19857 STUDIES ON THE POSTIRRADIATION OXYGEN EFFECT IN BACTERIAL SPORES. A. Tallentire and N. A. Dickinson (Univ. of Manchester, Eng.). J. Pharm. Pharmacol., 14: 127-8T(Dec. 1962).

Experiments were designed to elucidate the mechanisms of postirradiation effects of oxygen in bacterial spores. Kaolin powder contaminated with spores of Bacillus subtilis was dried, sealed under vacuum, and treated at 22° with up to 800 krad of γ radiation from a Co^{60} source. The criterion of lethal damage was the inability of the spore to give rise to a colony on incubation in nutrient agar. From colony counts of samples yielding surviving fractions less than 0.5, exponential dose/survival curves were constructed and the slopes estimated using the expression: surviving fraction = e^{-kD}, where k is the slope and D the dose in krad. The slope is used as a measure of the lethal efficiency of the radiation, higher values of k indicating greater efficiency. The highest level of lethal efficiency shown is that resulting from postirradiation storage of spores in oxygen for 48 hr ($k = 0.045$ krad^{-1}). The lowest efficiency is that for identical oxygen treatment preceded by exposure to nitric oxide for 15 min ($k = 0.010$ krad^{-1}), showing the prevention of the postirradiation oxygen effect by nitric oxide. Also, the development of the postirradiation oxygen effect can be arrested by removing the oxygen and can be restarted by re-admitting oxygen to the dried spore system. Treatment with nitric oxide between exposures to oxygen, however, prevents further development of the oxygen effect. (TCO)

19858 DEVELOPMENT OF BONE MARROW DAMAGE AS A RESULT OF TREATMENT FOR BREAST CANCER. Frigyes Godan. Magy. Onkol., 6: 138-41(Aug. 1962).

A fatal case of myeloid aplasia following radiotherapy is described. (H.H.D.)

19859 THE EFFECT OF BONE MARROW IRRADIATED IN VIVO AND IN VITRO ON THE LIVER REGENERATION OF RATS. Endre Czeizel, Gyoergy Vaczó, and Pál Kertai. Magy. Radiol., No. 5, 293-7(1962).

Partially hepatectomized rats were exposed to whole-body irradiation of 100 to 1000 r. A suspension of in vivo irradiated bone marrow was prepared from the femurs and tibias of some of the exposed rats. A suspension was also prepared from bone marrow taken from unexposed animals and irradiated in a test tube. The suspensions were injected into the bones of healthy animals and their effects studied. A considerable decrease was observed in the liver regeneration in rats exposed to whole-body irradiation, although their liver region was protected by sheet lead; this is attributed to bone marrow irradiation. Irradiation of bone marrow or injection into the bones of healthy animals of a suspension of in vivo irradiated bone marrow inhibits the liver regeneration in proportion with the dose of exposure. Injection of in vitro irradiated bone marrow suspension stimulated regeneration provided that the doses did not exceed 400 r but had an inhibitory effect if the dose was above 400 r. (OTS)

19860 THE INFLUENCE OF IONIZING RADIATION ON THE CARDIOVASCULAR SYSTEM IN RADIATION THERAPY OF PATIENTS WITH TUMORS. S. S. Mindlin. Med. Radiol., 8: No. 3, 26-30(Mar. 1963). (In Russian)

Studies were made of the effect of preoperative and postoperative roentgen therapy on various indices of the cardiovascular system of 78 women suffering from milk-duct carcinoma. The development of a number of reversible functional shifts was apparent. The changes occurred most frequently when the tumor was localized in the left mammary gland and in consecutive pre- and postoperative irradiation. The alterations were more common and marked in patients affected with concomitant diseases of the cardiovascular system, however, neither stable organic changes, nor manifestations of compensatory disorders, or of acute coronary insufficiency were observed. (auth)

19861 THE EMPLOYMENT OF A CIRCULAR SUTURE ON VESSELS AND NERVES IN THERMAL BURNS AND RADIATION SICKNESS. L. A. Melnik. Med. Radiol., 8: No. 3, 43-9(Mar. 1963). (In Russian)

Experimental investigations on dogs are reported pertaining to the feasibility of utilizing circular sutures on vessels and nerves during the simultaneous treatment of thermal burns and radiation sickness. (auth)

19862 THE RESULTS OF INVESTIGATIONS OF THE HIGHER NERVOUS ACTIVITY OF THREE GENERATIONS OF RATS, THE PARENTS OF WHICH UNDERWENT IRRADIATION WITH GAMMA-RAYS OF Co^{60}. M. S. Slekseeva and V. K. Fedorov. Med. Radiol., 8: No. 3, 50-7 (Mar. 1963). (In Russian)

Physiological indices were measured of general development and higher nervous activity of rats. The parents of which for three generations were subjected to daily gamma-irradiation in a dose of 5 r with a total of 50 r. Simultaneously investigations were carried out in control animals. A total of 355 rats were under experimentation. (auth)

19863 THE INFLUENCE OF AN INFLAMMATORY PROCESS IN THE LUNGS ON THE DISTRIBUTION OF RADIOSTRONTIUM IN THE ORGANISM. V. S. Kalistratova. Med. Radiol., 8: No. 3, 57-60(Mar. 1963). (In Russian)

Inflammatory processes in the lungs are conducive to a reduced concentration of Sr^{90} in the skeleton when the isotope is introduced against the background of inflammation, and does not exert any influence on the radiostrontium concentration in the bone tissue if it were fixed by the skeleton earlier. In administration of Sr^{90} on the 5th day of pneumonia there is noted an accumulation of the isotope in the inflammatory focus of the lungs one day after its administration. At later periods of pneumonia and in administration of Sr^{90} prior to microbial infection of animals there is seen a certain decrease of the isotope concentration in the inflammatory focus. (auth)

19864 MORPHOLOGICAL CHANGES IN DOGS AT REMOTE PERIODS FOLLOWING THE ADMINISTRATION OF Po^{210}. E. V. Erleksova. Med. Radiol., 8: No. 3, 61-6 (Mar. 1963). (In Russian)

Into the gastrointestinal tract of two dogs 0.05 mc/kg of Po^{210} was introduced; the animals were sacrificed 9 years later. Dystrophic changes of internal organs and profound affection of the liver were morphologically revealed: nodular hyperplasia of the organ as a compensatory-hyperplatic process with individual nodules in the form of tumor-like formations of the type of primary cancerous nodules, developing from hepatic cells and adenomas from bile ducts. Adenomas of the thyroid gland, adrenals, prostate, and seminoma of the testis developed in the organs of the endocrine system. The above changes in parenchymatous organs and in glands of the endocrine system are the remote sequelae consequent upon long-term continuous ionizing irradiation with Po^{210}. (auth)

19865 THE INFLUENCE OF PRELIMINARY VACCINATION WITH LIVE ANTIPLAGUE EB VACCINE ON THE RADIORESISTANCE OF ANIMALS. O. V. Smirnova. Med. Radiol., 8: No. 3, 66-70(Mar. 1963). (In Russian)

Experiments were carried out on albino mice, guinea pigs, and rabbits involving preliminary introduction of different doses of live antiplague EB vaccine before lethal and sublethal irradiation. The live antiplague EB vaccine exerted an aggravating effect on the course of radiation sick-

ness in albino mice and rabbits. The administration of large doses of the EB vaccine prior to irradiation increases the lethality of animals and shortens the average life expectation. Such an effect of the EB vaccine on the radioresistance of animals is due, apparently, to the presence of residual toxicity of the EB strain. (auth)

19866 ROENTGEN RADIATION AND FEMALE REPRODUCTIVE SYSTEM. F. J. Schoeneck (State Univ. of New York, Syracuse). N. Y. State J. Med., 62: 554-5 (Feb. 15, 1962).

The harmful somatic and genetic effects of diagnostic radiation on germ cells and the fetus are discussed. There is acceptable evidence, based on animal experimentation, that regardless of where radiation beams are directed, the ovaries are affected to some extent by scatter. A rational approach to the use of diagnostic x-ray technics should imply that where one cannot avoid a certain amount of necessary exposure, such exposure should be kept to a minimum. The increasingly prevalent idea of delaying routine chest x-ray films of pregnant women until at least the second, and preferably the third, trimester is a step in the right direction. This is true also of the use of lower dosage technics, utilizing full-size radiographs rather than the miniature film technic, which use fluoroscopic principles. Very little, if any, somatic harm should result from diagnostic procedures performed in an adequate fashion; however, all types of x-ray procedures carry a potential risk of some minimal damage. (H.H.D.)

19867 IMMUNOLOGICAL PROPERTIES OF TUMOURS. Norman Molomut, Leo Gross, and Morton Padnos (Waldemar Medical Research Foundation, Inc., Port Washington, N. Y.). Nature, 198: 38-9(Apr. 6, 1963).

The possibility of immunizing experimental animals against transplantable tumors was investigated in mice. Tumor immunity for homologous tumors such as Ehrlich's ascites carcinoma and isologous tumors such as lymphosarcoma closely paralleled the immune responses that have been observed for bacterial and for viral infections. The level of induced protection was affected by the anatomical site of immunizing injection and of challenge. It was found that x irradiation does not alter the antigenic properties of lyophilized tumor. It was concluded that x-irradiated cells are attenuated but viable and that this property enables the immune resources of the host to be mustered against them in sufficient time to reject the tumor. (C.H.)

19868 LIPID PEROXIDE IN LIVERS OF IRRADIATED RATS. P. B. McCay (Lister Inst. of Preventive Medicine, London), Marjorie G. MacFarlane, and E. Boyland. Nature, 198: 98-9(Apr. 6, 1963).

Radiation effects on the lipid peroxide content and phospholipid distribution in the livers of rats were measured. No significant differences were found in peroxide content of chloroform-methanol extracts of liver or in fatty acid ester content of liver from control and irradiated rats. (C.H.)

19869 VARIETY, DEVELOPMENTAL STAGE AND DOSE RATE IN IRRADIATION OF THE POTATO. P. B. Mathur (Atomic Energy Establishment, Trombay, India). Nature, 198: 99(Apr. 6, 1963).

A dose of 3,000 rads/min was found to be more effective than a dose rate of 250 rads/min when the same dose was applied for the prevention of sprouting in potatoes exposed to Co^{60} γ rays before cold storage. Larger radiation doses were required to prevent sprouting when the potatoes were exposed near the end of the dormancy period. Variations in response to radiation were observed in two strains of potatoes. (C.H.)

19870 SOMATIC HAZARDS OF RADIATION. Austin M. Brues (Univ. of Chicago). Proc. Am. Phil. Soc., 107: 1-4(Feb. 1963).

The somatic effects of radiation on man are discussed. Data from animal studies and available data on human populations are reviewed. It is pointed out that somatic effects of radiation include cancer, leukemia, and degenerative changes similar to those observed in aging. (C.H.)

19871 THE CLINICAL AND PATHOLOGICAL EFFECTS OF RENAL IRRADIATION. Reginald W. Luxton (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Progr. Radiation Therapy, 2: 15-34(1962).

From a study of 54 patients over a 13-yr period the following radiotherapy-induced syndromes are described: acute and chronic radiation nephritis, benign hypertension, late malignant hypertension, and proteinuria. Of 20 patients who were followed, 8 had malignant hypertension, of whom 6 died within 3 to 12 months. The remaining 2 recovered spontaneously from the malignant phase of hypertension, but 1 of the 2 died 6 years later with chronic renal failure. In patients who survived acute radiation nephritis, improvement usually began within 6 months after the first symptom. Of the patients who have not died from the effects of renal irradiation, 1 died of recurrent ovarian malignancy. The remaining 9 are alive and active at an average interval of 10 years after radiotherapy, although all show evidence of chronic nephritis. The main histological findings of acute radiation nephritis comprise thickening of the renal capsule, widespread glomerular damage (hyaline obliteration of capillary loops, necrosis of fibrinoid or of hemorrhagic type with proliferation of capsular epithelium and early capsular fibrosis), extensive tubular degeneration and atrophy, diffuse intertubular fibrosis, and fibrinoid necrosis of arterioles and interlobular arteries. The glomerulus is the primarily affected portion of the kidney and tubular atrophy is secondary. Under modern conditions, radiation nephritis is largely a preventable disorder. (TCO)

19872 INORGANIC CONSTITUENTS OF THE DIET AND RADIOSENSITIVITY: LETHAL RESPONSE TO X RAYS AND TO NITROGEN MUSTARD OF RATS FED DIETS SUPPLEMENTED WITH MANGANESE. R. Angelico, Lucia Maggiore, and M. Quiatiliani (Istituto Superiore di Sanita, Rome). Rend. Ist. Super. Sanita, 24: 711-26(1961).

Experiments were conducted in rats fed diets enriched with 3 to 33 mg Mn per day (as $MnCl_2$) above the basal diet content of 15 μg Mn per day. In general, Mn supplementation decreased the growth of rats, the decrease exceeding 50% at the highest Mn level (33 mg/day). Whole-body irradiation of the rats was carried out with 624 r on the 75th day of the dietary regimen. Rats on the basal diet showed a 30-day mortality rate of 72%. This was in contrast to rats on 2.78, 11.12, 16.68, and 22.24 mg/day Mn supplements, which showed respective 30-day mortality rates of 76, 65, 67, and 64%. Hence, no significant radioprotective effect of dietary Mn was demonstrable. In another group of rats on similar diets, nitrogen mustard (1.2 mg/kg body wt) was injected intraperitoneally and the 15-day mortality rate was determined. This was significantly lower (38%) in rats fed 16.68 mg Mn per day than in controls on the basal diet (64% mortality). No explanation could be offered for the partial protective action of Mn against nitrogen mustard. (H.H.D.)

19873 THE EFFECT OF LOW RADIATION DOSES ON SPERMATOGONIA AND OOCYTES OF THE MOUSE. E. F. Oakberg (Oak Ridge National Lab., Tenn.). Strahlentherapie, Sonderbaende, 51: 103-11(1962). (In English)

Quantitative histological methods have been used to study

the effect of low doses of gamma rays and neutrons on spermatogonia of the mouse. It was possible to detect a reduction in number of spermatogonia after 3 rads of Co^{60} gamma rays, 2 rads of 2.5 Mev neutrons, and 1.5 rads of 14.1 Mev neutrons. The extreme sensitivity of oocytes in the earliest follicle stages of 10-day-old females to gamma rays suggests that the effect of even lower doses than those given above may be detected. While no effect on other parameters has as yet been demonstrated from doses of this magnitude on germ cells, these data nevertheless demonstrate that very low doses of radiation can kill cells, and the possibility of the induction of other effects, such as genetic damage, remains a reality. (auth)

19874 CONTRASTS IN RADIATION-INDUCED MUTATION RATES AT DIFFERENT MEIOTIC STAGES. Anna R. Whiting (Oak Ridge National Lab., Tenn. and Univ. of Pennsylvania, Philadelphia). Strahlentherapie, Sonderbaende, 51: 183-95(1962). (In English)

Results are reported from studies on the innate resistance to radioinduced mutations in mice, Drosophila, Habrobracon, and other insects. X-ray induced dominant lethal rates are used as the basis for comparison between meiotic stages and species. (C.H.)

19875 ENZYMATIC MEASUREMENT OF THE RADIOPROTECTIVE ACTIVITY OF CHEMICAL AGENTS. Bernard E. Hietbrink, Ann B. Raymund, Gerald R. Zins, and Kenneth P. DuBois (Univ. of Chicago). Toxicol. Appl. Pharmacol., 3: 267-77(May 1961).

An attempt was made to find new radioprotective agents and combinations of chemical agents that might provide protection against both intestinal and hematopoietic injury from radiation exposure. Protective activity of chemicals was detected by measuring their ability to reduce the increase in adenosinetriphosphatase (ATPase) activity of spleen and the decrease in acetylcholinesterase activity of the intestine caused by 400 r whole-body x irradiation of rats. Single compounds and combinations that were found by means of enzyme assays to afford protection were then tested for their ability to prevent mortality of irradiated animals. Administration of 75 mg/kg of hydroxylamine reduced the amount of radioinduced increase in ATPase activity of spleen by 79%. Thus the amount of change in enzyme activity in the spleens of rats given 400 r and 75 mg/kg of hydroxylamine was equivalent to the increase that would be obtained with 80 r in unprotected irradiated rats. Cysteine (1000 mg/kg) and glutathione (900 mg/kg) also caused substantial reductions in the biologically effective dose of radiation in the spleen and intestine when given prior to x ray. Survival studies indicated that all 3 compounds provide a similar amount of protection. Combinations of hydroxylamine with cysteine, glutathione, or AET were more effective in preventing radioinduced mortality than any of the compounds given alone. (TCO)

19876 CHEMICAL PROTECTION AGAINST IONIZING RADIATIONS. Z. M. Bacq (Université, Liège). Triangle. Sandoz J. Med. Sci., 5: 2-11(Apr. 1961). (In French)

The mechanism of action of radioprotective agents is considered in relation to their chemical structure. The following types of compounds are considered: sulfhydryl compounds, nitriles, chelating agents, hydroxyl compounds, and anoxemic substances. Injection of 150 mg/kg cysteamine 1 min before x irradiation of mice with 750 to 800 r, delivered over a 25-sec period, prevented the death of 97% of the animals, compared with a mortality rate of 97% in uninjected controls. However, injection of cysteamine at the same dose 30 sec after irradiation had no protective effect. Three theories of the mechanism of action of radioprotectant agents are discussed: chemical protection as the result of tissue anoxia; protection of sulfhydryl groups by the formation of mixed disulfides; and neutralization of free radicals. It was concluded that the only logical explanation for the protectant action of substances such as cysteamine is that they somehow intervene in the physicochemical reactions that occur immediately after the absorption of radiation energy by tissue components. Several protectant mechanisms may be operative, but, it is suggested, the one involving free radicals is probably the most important. (TCO)

19877 COMPATIBILITY FACTORS INFLUENCING THE ACCEPTANCE OF RAT BONE MARROW GRAFT BY THE IRRADIATED MOUSE. J. W. Hollingsworth (Veterans Administration Hospital, West Haven, Conn. and Yale Univ., New Haven, Conn.). Yale J. Biol. Med., 31: 157-63(Dec. 1958).

Studies on marrow from humans, guinea pigs, rats, rabbits, and hamsters showed that rat bone marrow is the only heterologous marrow that is acceptable to the irradiated mouse. Other rodent erythrocytes are basically incompatible in the mouse and are rapidly destroyed even by the irradiated mouse recipient. The implications of the findings in relation to the acceptance of heterologous bone marrow grafts are discussed. One suggestion is the marked antigenic similarity of the mouse and rat erythrocyte. (P.C.H.)

19878 CONCERNING THE INFLUENCE OF CULTURE CONDITIONS ON THE RADIATION SENSITIVITY OF GLUCOSE OXIDATION IN BACTERIUM CADAVERIS. H. Pauly (Max-Planck-Institut fur Biophysik, Frankfurt am Main). Z. Naturforsch., 18b: 23-5(Jan. 1963). (In German)

For B. cadaveris that were cultivated in a medium rich in organic materials the O_2 consumed per unit of time for glucose consumption by breathing decreased with x-ray dose, while for bacteria that were grown in salt medium the consumption by breathing first rose, up to a dose of 2 to 3 Mr, then decreased at higher doses. The consumption by breathing was first influenced noticeably at doses on the order of one million r. The consumption by breathing of bacteria, under the conditions investigated, was still more resistant to radiation than the tissue consumption by breathing of mammal cells. (tr-auth)

19879 CONCERNING THE HINDRANCE OF THE GROWTH OF BACTERIUM LACTIS AEROGENES BY X RADIATION. Detlev Kayser (Max-Planck-Institut fur Zellphysiologie, Berlin). Z. Naturforsch., 18b: 171-2(Feb. 1963). (In German)

X rays were earlier found to hinder the breathing of B. lactis aerogenes by H_2O_2 produced in the cell suspension by radiation. Tests run to see if growth was hindered by the same effect gave positive results. (M.C.G.)

19880 ANTHRAX IMMUNITY UPON THE ACTION OF IONIZING RADIATION ON THE ORGANISM. E. I. Silant'ev, V. A. Ankudinov, and S. G. Kolesov. Zh. Mikrobiol., Epidemiol. i Immunobiol., No. 11, 121-3(1962).

The possibility of developing a specific immunity to anthrax in animals irradiated before and after inoculation with live anthrax vaccine was investigated. In two groups of guinea pigs the relation between the anthrax immunity and a mild form of radiation sickness was studied. Three out of 22 animals irradiated prior to immunization perished. None of the animals irradiated after immunization died. Radiation doses that caused a relatively mild form of radiation sickness had no effect on the formation of a specific

anthrax immunity and do not change the animal's resistance to this infection after vaccination, provided that the interval between immunization and irradiation was not less than 9 to 10 days. Animals immunized before irradiation with low doses retained their specific anthrax immunity. Two to three weeks after the exposure of nonimmunized animals to the same radiation doses a stable anthrax immunity developed after inoculation with vaccine. (OTS)

19881 THEORETICAL ASPECTS OF CHEMICAL PROTECTION OF MAMMALS AGAINST IONIZING RADIATION. E. Ya. Grayevskii. Zh. Obshch. Biol., 24: 3-22(Jan.-Feb. 1963).

The antiradiation action of chemical substances is manifested only if they are present in the organism during irradiation. The protectors differ both with respect to structure and physiological effect. For the most part their protective action is of short duration; for example, cysteine, cysteamine, cystamine, carbon monoxide, sodium nitrite, and p-aminopropiophenone exert a strong radioprotective effect, and metabolites a moderate degree of protection, for a short time. Conversely, urethane, colchicine derivatives, reserpine, sodium fluoroacetate, and hormones are weak protectors but are active for a prolonged period. The mechanism of the action of chemical protectors has not been fully determined, but two are considered plausible. One is based on anoxia in which radiosensitivity is reduced because of a lowering of the partial pressure of oxygen in the cells. The second is based on alleviation of symptoms of the radiation syndrome by a chemical combination of the protective agents with intracellular structures. (OTS)

19882 SOME ASPECTS OF INTERNAL IRRADIATION. Proceedings of a Symposium held at The Homestead, Heber, Utah, 8-11 May, 1961. Thomas F. Dougherty, Webster S. S. Jee, Charles W. Mays, and Betsy J. Stover, eds. New York, Pergamon Press, 1962. 543p.

Thirty-three papers presented at a symposium on pathological effects of internally deposited radionuclides are included. Separate abstracts were prepared for twenty-five papers. Eight have been abstracted previously for NSA. (A.G.W.)

19883 STUDY OF THE LONG TERM BIOLOGICAL EFFECTS OF INTERNAL IRRADIATION IN ADULT BEAGLES. T. F. Dougherty (Univ. of Utah, Salt Lake City). p.3-6 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

A comparative study of the biological effects in adult beagles of the internal irradiation resulting from Ra^{226}, Pu^{239}, Ra^{228}, Th^{228}, and Sr^{90} was described. The number of dogs to be injected with each dose level of each nuclide, the number already injected, and the number of dead dogs are listed. (A.G.W.)

19884 STUDIES OF THE RETENTION AND DISTRIBUTION OF Ra^{226}, Pu^{239}, Ra^{228}, ($MsTh_1$), Th^{228}, (RdTh), AND Sr^{90} IN ADULT BEAGLES. Betsy J. Stover, D. R. Atherton, and C. W. Mays (Univ. of Utah, Salt Lake City). p.7-25 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

The biological behavior of Ra^{226}, Pu^{239}, Th^{228}, and Sr^{90} in young adult beagles for the first 1000 days following a single intravenous injection was studied. Plasma concentration, excretion, fractional retention, distribution, metabolic fate of the decay products, if any, and the average radiation dose rate to the skeleton were determined. The results are considered in terms of the nuclear and chemical characteristics of the radionuclides and the biological organism. The results for the pair of alkaline earth radionuclides are, in general, similar with interesting small differences, and this pair differs markedly from the pair of actinide element radionuclides, which in turn shows some interesting similarities and dissimilarities. The combined effect of nuclear and chemical properties and the biological organism result in markedly different average radiation dose rates to the skeleton when compared on the basis of equal injected activities. The empirical relations are presented as useful interpolation formulae to describe a specific case. (auth)

19885 RELATIONSHIP OF MICRODISTRIBUTION OF ALPHA PARTICLES TO DAMAGE. W. S. S. Jee, J. S. Arnold, T. H. Cochran, J. A. Twente, and R. S. Mical (Univ. of Utah, Salt Lake City). p.27-45 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Autoradiographic studies of the distribution of Pu^{239}, Ra^{226}, Ra^{228}, and Th^{228} in adult beagles are summarized. Patterns of distribution in both mineralized and soft tissues are shown. Variations in local dose due to differential uptake of isotopes, changes in dose rate with time after injection, and relation of dose to damage are discussed. (A.G.W.)

19886 INCIDENCE OF BONE CANCER IN INTERNALLY IRRADIATED DOGS. Thomas F. Dougherty (Univ. of Utah, Salt Lake City). p.47-57 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Adult beagles were injected with varying dose levels of Ra^{226}, Pu^{239}, Ra^{228}, Th^{228}, and Sr^{90} according to a schedule that began in 1952 and is still incomplete. The number of dogs that died from osteosarcoma or other causes, the days from time of injection to death, and the absorbed radiation dose to the skeleton are discussed in this interim report. In general, osteosarcoma was the major cause of death. Variables that influence carcinogenesis in the experiment are considered. (A.G.W.)

19887 RADIOGRAPHIC CHANGES IN INTERNALLY IRRADIATED DOGS. William R. Christensen, Carlisle C. Smith, Carl E. Rehfeld, and Glenn N. Taylor (Univ. of Utah, Salt Lake City). p.63-77 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

In adult beagles injected with varying dosages of Ra^{226}, Ra^{228}, Th^{228}, and Pu^{239} the following changes have been established as evidence of radionuclide injury: structural changes in the mandible; destructive changes in the teeth; pathological fractures with and without healing; distortion of cortex of long bones; disturbance of metaphyseal trabeculation; osteolytic rarefaction; rib end demarcation; aseptic necrosis; tumor formation. As a general rule, changes appearing in the mandible, amorphous sclerosis of interalveolar crests, and loss of differentiation between lamina dura and periodontal membrane are the earliest and most common manifestations of radionuclide intoxication. There is no specificity or rigid consistency in the skeletal changes produced. In any single instance of nuclide toxicity it would be impossible, on the basis of experience to date, to identify the inciting agent from radiological evidence. (A.G.W.)

19888 SOME HEMATOLOGICAL RESPONSES TO INTERNAL IRRADIATION IN THE BEAGLE. Jean H. Dougherty (Univ. of Utah, Salt Lake City). p.79-93 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Chronic hematological changes in adult beagles injected with varying doses of Ra^{226}, Ra^{228}, Pu^{239}, Th^{228}, and Sr^{90} are summarized. Graphs show mean values of volume of packed red cells, sedimentation rate, platelets, polymorphonuclear neutrophils, and lymphocytes at monthly or three monthly intervals after injection for each radionuclide. In general,

there is a dose response effect on blood cells for all radionuclides; but Th^{228} appears to be most toxic. Factors such as metabolism of the radionuclide and its location in bone and amount in soft tissues apparently enter into changes in hematopoiesis as well as total radiation dose or dose rate. (A.G.W.)

19889 HISTOPATHOLOGICAL ENDPOINTS IN COMPACT BONES RECEIVING ALPHA IRRADIATION. W. S. S. Jee (Univ. of Utah, Salt Lake City). p.95-116 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Tibial diaphyses from 15 controls and 46 beagles given a single intravenous injection of one of the bone-seeking radionuclides (Pu^{239}, Ra^{226}, Ra^{228}, or Th^{228}) were analyzed for patent vascular channels, viable osteocytes bone resorption, canal plugs, forming osteones, abnormal osteones, hypomineralized osteones, hypomineralized osteones with enlarged canals, and porosity. Structural changes in compacts containing internally deposited α emitters appeared to be dose dependent. High radiation doses altered the circulation, produced bone necrosis and bizarre osteones, stimulated bone resorption, and inhibited bone formation. The increased accumulations of these structures indicated a more rapid turnover rate for the radionuclide-bearing dogs as compared to controls. Time played an important role in that many of the changes were cumulative. The circulation factor was mainly responsible for the altered remodelling. (A.G.W.)

19890 THE EFFECT OF AGEING AND INTERNAL EMITTERS ON BLOOD CHEMISTRY. Harold C. Goldthorpe (Univ. of Utah, Salt Lake City). p.117-29 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

A record of blood chemistry values is being obtained on approximately 100 normal dogs throughout their lifespan. Values for the various serum constituents in these normal aging dogs are summarized. Terminal values for the serum constituents in dogs injected with Ra^{226}, Ra^{228}, Pu^{239}, or Th^{228} are compared with the normal values. Special emphasis was placed on those groups in which a large number of the dogs had bone tumors at the time the measurements were made. The most striking change was the elevation of the mean values of alkaline phosphatase for almost all the groups in which bone tumor incidence is high. Pu^{239} dogs and some of the Th^{228} dogs showed a slight decrease in Ca with a slight increase in inorganic phosphates. In the study of serum proteins an advancement in time of the normal reversal of the albumin–globulin ratio was found. (A.G.W.)

19891 FRACTURE INCIDENCE IN BEAGLES RECEIVING SINGLE INJECTIONS OF RADIUM OR PLUTONIUM. C. E. Rehfeld, B. J. Stover, G. N. Taylor, and C. W. Mays (Univ. of Utah, Salt Lake City). p.131-43 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Data collected since 1952 on incidence of fractures in beagles given single injections of Ra^{226} or Pu^{239} are presented. The fracture rate is highest in the highest dose levels. There is good correlation for fracture incidence and the dose rate in Ra^{226}-injected dogs, but such correlation is less obvious with Pu^{239}. Rib fractures were more numerous in dogs given Ra^{226}, and rate of repair was much greater than with Pu^{239}. Only Ra^{226}-treated dogs had long bone fractures and only Pu^{239}-treated dogs had pelvic fractures. Approximately equal numbers of both groups had fractures of irregular bones but the average number per dog was greater for Pu-treated animals. (A.G.W.)

19892 RADIONUCLIDES AND BONE STRENGTH. D. H. Taysum, F. G. Evans, W. M. Hammer, W. S. S. Jee, C. E. Rehfeld, and L. W. Blake (Univ. of Utah, Salt Lake City). p.145-62 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Tibiae were removed at autopsy from dogs that had received single injections of Ra^{226}, Ra^{228}, Th^{228}, Pu^{239}, and Sr^{90}. Regularly shaped test specimens were subjected to pure tensile stresses. Results are tabulated. It is concluded that age and radiation dose in the ranges investigated do not weaken bone substance enough to account for the observed fractures, and the cause of spontaneous fractures is tentatively assigned to localized faults. (A.G.W.)

19893 EYE CHANGES INDUCED BY INTERNAL IRRADIATION. G. N. Taylor, C. E. Rehfeld, G. Schneebeli, and H. A. Johnson (Univ. of Utah, Salt Lake City). p.163-78 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Grossly apparent iris and choroidal changes were induced in beagles by the intravenous injection of Ra^{226}, Ra^{228}, Th^{228}, or to a lesser and variable extent by Pu^{239}. Alterations were not seen following treatment with Sr^{90}. Changes were limited to the pigmented parts, which have previously been shown to retain relatively significant amounts of Ra^{226}, Th^{228}, or Pu^{239}. The principal symptoms included hyperpigmentation of the iris at low doses and depigmentation of the iris, choroid, and tapetum lucidum at higher doses. A dose-time-effect relationship exists except for Pu^{239}. Intraocular neoplasms or an abnormal incidence of cataracts were not observed. Loss of iris and choroidal pigment and degeneration or complete loss of the tapetum lucidum layer at higher doses were seen microscopically. (auth)

19894 THE EFFECTS OF CHRONIC IRRADIATION BY INTERNALLY DEPOSITED RADIONUCLIDES ON CORTICOSTEROID BIOSYNTHESIS. D. L. Berliner, M. L. Berliner, and T. F. Dougherty (Univ. of Utah, Salt Lake City). p.179-86 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Data are presented on the influences of Sr^{90}, Th^{228}, Ra^{228}, Ra^{226}, and Pu^{239} on the biosynthetic capabilities of the adrenal glands of dogs sacrificed from 24 hr to 6 yr after injection of the radionuclides. The effect of the internal emitters appeared to be a decrease in 11-, 17-, and 21-hydroxylations. The most marked effect was the reduction of 17-hydroxylation, which is mainly located in the reticuloendothelial cell. It was demonstrated that the addition of reduced triphosphopyridine nucleotide can restore normal hydroxylating activity. (A.G.W.)

19895 ROLE OF HORMONES IN RADIATION CARCINOGENESIS. Jacob Furth and Kenjiro Yokoro (Univ. of Buffalo, N. Y.). p.189-205 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Radiation carcinogenesis is a complex process, and radiation-induced tumors vary in character. Radiation can initiate and promote tumor growth, but it can also prevent tumor growth. Radiations can produce progressively growing tumors either by direct alteration of a cell or by disturbing its homeostatic regulating organ. Doses of radiation large enough to inhibit proliferative capacity of cells will diminish the likelihood of tumor development in those cells. Hormones are powerful promoters of all carcinogens, including radiations. They act by increasing cell numbers, by bringing many cells in stages with heightened sensitivity to ionizing radiations or acceptance of virus. (A.G.W.)

19896 PROBLEMS OF LOW-LEVEL IRRADIATION. R. H. Mole (Medical Research Council, Harwell, Berks,

Eng.). p.207-232 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Low-level irradiation in this discussion means a level of irradiation that produces a low level of effect. Carcinogenesis as an effect of radiation is emphasized. Questions discussed include the following: Are the effects of low-level irradiation to be expressed in proportional or absolute terms? How much repetition of observations is necessary before firm conclusions can be drawn, and how can biological comparability in long-term experiments be ensured? How important are rare events, and is cancer a rare event? Can data be extrapolated from experimental animals to man without understanding the mechanism of production of the effect involved? (A.G.W.)

19897 RADIOLOGIC AGING, GENERALIZED AND LOCALIZED (WITH SPECIAL REFERENCE TO INTERNAL IRRADIATION). G. W. Casarett (Univ. of Rochester, N. Y.). p.251-68 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

General considerations of actuarial, pathologic, histopathologic, and physiologic changes following irradiation, in comparison with the manifestations of "normal" aging, indicate a strong resemblance between the late effects of life-shortening total-body irradiation and the manifestations of premature aging, especially with respect to the histopathologic manifestations preceding disease. The histopathologic changes preceding disease development at the site of localized irradiation from external sources or from internal radioisotopic sources also bear a strong resemblance to the histopathologic manifestations of aging and therefore suggest the concept of premature localized aging resulting from localized irradiation. Although the processes and manifestations of "normal" aging and "radiologic aging" at the histopathologic level are similar, their nonspecificity makes it impossible to predict whether or not the more fundamental underlying processes will be similar or quite different. (auth)

19898 THE RESPONSE OF THE BLOOD-FORMING TISSUE OF THE RAT TO CONTINUOUS IRRADIATION AT VARIOUS DOSE RATES. L. F. Lamerton (Royal Cancer Hospital, London). p.269-87 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

The response of the blood and blood-forming tissues of rats continuously irradiated by an external γ source at dose rates of 176, 84, 50, 16, and 4 rad/day was studied. A special study was made of the response at 50 rad/day, at which dose rate a steady state of the peripheral blood count can be maintained for a considerable period of time. Evidence was found that the erythropoietic system can withstand higher dose rates of continuous irradiation than either the granulocytic or thrombocytic systems and that the epithelium of the small intestine can maintain function under a much higher continuous dose rate than the blood-forming tissues. Shielding of one hind limb during exposure of rats to daily doses of radiation resulted in longer life and much less severe hemoglobin fall. (A.G.W.)

19899 EFFECTS OF FETAL X-IRRADIATION ON AGING CHANGES IN CEREBRAL CORTEX. K. R. Brizzee, Xenia Kharetchko, and L. A. Jacobs (Univ. of Utah, Salt Lake City). p.289-301 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Pregnant white rats were exposed to a fractionated dose of whole-body x irradiation totaling 300 r on gestation days 10 through 14. Animals from the irradiated litters were sacrificed at 100, 200, 300, and 400 days of age and studies were made of mean neuronal nuclear, perikaryal and soma volumes, neuron and neuroglial packing densities, and cortical thickness. In comparison with control animals at 400 days of age, there was a decrease in neuron nuclear, cytoplasmic, and soma volumes and a significant increase in the glia density, glia/neuron index, and gray/cell coefficient in the irradiated animals. (A.G.W.)

19900 PATHOLOGIC SEQUELAE IN BEAGLES FOLLOWING CONTINUOUS FEEDING OF Sr^{90} AT A TOXIC LEVEL. A. C. Andersen and M. Goldman (Univ. of California, Davis). p.319-28 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Pathological events in beagles fed a toxic level of Sr^{90} from in utero to 18 months of age were studied. Histologic examination of the femur of a pup sacrificed at birth gave evidence of disturbed ossification although the skeleton appeared normal upon gross examination. Malignant soft tissue neoplasms (lymphoblastic or reticulum cell sarcomas) preceded bone neoplasia. Two years after Sr^{90} administration one dog succumbed to osteogenic sarcoma in lumbar vertebrae. The long-term effect of Sr^{90}, besides neoplasms, is a slow process in bone that forms non-osseous low-density tissue. (A.G.W.)

19901 DENTAL CHANGES IN RABBITS INDUCED BY Sr^{90}. M. A. Rushton (Guy's Hospital, London). p.349-59 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Single injections of 100 to 1000 μc/kg of Sr^{90} were given to rabbits, weanlings and older. The most severe changes in the teeth and surrounding tissues were produced in weanling rabbits receiving a high injected dose. The effects in a series of 34 animals that had 600 μc/kg as weanlings are described. Rabbits receiving the same dose at 1 to 3 years showed less severe effects on the teeth. Rabbits injected as weanlings with 100 μc/kg did not show arrested growth of the teeth. For this reason the Sr^{90} incorporated in the teeth in those animals was removed from the teeth by attrition. In animals receiving 600 μc/kg or more as weanlings, growth and eruption of the cheek teeth were arrested, and the Sr^{90} incorporated in the teeth remained there substantially during the whole period of observation. (A.G.W.)

19902 PRELIMINARY STUDY OF THE EFFECT OF INTERNAL IRRADIATION FROM Sr^{90} ON THE BONE MARROW AND PERIPHERAL BLOOD PICTURE OF YOUNG RABBITS. Janet Vaughan (Medical Research Council, Oxford). p.361-77 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

The relationship of the peripheral blood picture to the marrow cellularity in tibia and vertebra and the radiation dose in young rabbits receiving a single intravenous injection of 600 μc/kg of Sr^{90} was studied. The pattern of radiation dose rate and therefore of marrow cellularity even in the same bone is complex because of differences in Sr^{90} distribution. In areas of marrow receiving a high initial dose rate, aplasia occurs within 24 to 48 hr. As the dose rate falls there is partial or complete recovery. Initial marrow aplasia is associated with a fall in hemoglobin, total white cells, platelets, and reticulocytes. Death may occur about the 18th day; if not, there is a recovery of all peripheral blood elements to low normal or high subnormal levels. During the second three months after injection hemopoiesis may be affected by factors other than irradiation of the marrow, such as general metabolic disturbance evidenced by slowing of growth and development of widespread osteosarcoma. (A.G.W.)

19903 INTERACTIONS OF α AND β PARTICLES WITH MATTER. R. D. Evans (Massachusetts Inst. of Tech.,

Cambridge). p.381-96 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

In work on toxicity of internally deposited radionuclides, α-particle energies from 4.78 to 8.78 Mev and β-particle energies from 0.05 to 3.26 Mev are of interest. Properties of these particles summarized include the following: velocity, energy spectra, scattering, mean linear energy transfer, range, relative stopping power, straggling, and results of collisions with atomic nuclei. (A.G.W.)

19904 THE RELATIONSHIP BETWEEN ALPHA AND BETA DOSIMETRY. L. F. Lamerton (Royal Cancer Hospital, London). p.397-407 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

The extent to which detailed investigations of radiation dose distribution are practicable and worthwhile in studies with bone-seeking radioactive isotopes is considered. The main problems involved concern techniques presently available for dose measurement, the type or types of cell to be considered, and the period over which the radiation dose should be integrated. Special problems encountered at low dose levels are also discussed. It is concluded that, in the present state of knowledge, dose distribution studies would appear to be most valuable in investigations of comparative carcinogenic effectiveness where the number of dosage variables is small, for instance, in studies of differences in tumor incidence following different patterns of administration of the same isotope. (A.G.W.)

19905 Sr^{90} DOSIMETRY IN RABBITS. Maureen Owen (Churchill Hospital, Oxford). p.409-21 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Young (aged 5 to 8 weeks) and adult (aged 21 to 47 months) rabbits were given a single intravenous injection of Sr^{90} and killed at varying times after injection. Dosimetric measurements were made by an autoradiographic method on the proximal portion of the tibia, the vertebra, and part of the lower mandible including the molar and premolar teeth. In the young rabbits the maximum accumulated dose was received in the jaws and tibia and was about 3 to 4 times that found in the vertebra. In the adult rabbits the maximum dose was received in the jaws and was about 9 times that received in the tibia and vertebra. A correlation was found between sites of maximum accumulated dose and sites of osteogenic sarcomas. The adult animals appeared to have greater resistance to tumor development than the young animals. (A.G.W.)

19906 THEORETICAL AND EXPERIMENTAL DOSIMETRY BASED ON MODELS OF BONE STRUCTURE. F. W. Spiers and M. Susan Chesters (Univ. of Leeds, Eng.). p.423-35 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Theoretical dose rate calculations for a number of simplified geometrical models of isotope depositions in bone are reviewed. Experimental models representing a slab and a cylinder of bone were made from compressed salts having the atomic composition of mineral bone and containing Sr^{90}. A dense liquid and polythene sheet were used in a layer model of trabecular bone. Dose-rate measurements in relation to each model were made with a plastic scintillator. The results appear to provide experimental justification for the use of the mathematical methods developed for the slabs and cylinders. Further measurements on trabecular-bone models having different bone marrow ratios are being made. (A.G.W.)

19907 THOROTRAST IN MAN—THE CARRIER STATE AND THE SEQUELAE. Mogens Faber (Finsenlaboratory, Copenhagen). p.473-98 of "Some Aspects of Internal Irradiation." New York, Pergamon Press, 1962.

Colloidal thorium dioxide, under the trade name thorotrast, has been used as a contrast medium for x-ray studies requiring intracanalicular or intravascular injection. After intracanalicular injection, the thorotrast stays at the place of injection and appears to be carcinogenic there. After injection into the blood stream, thorotrast is deposited in phagocytic cells. A redistribution starts immediately and continues for years while an increasing amount of thorotrast collects in connective tissue. The mechanism of this redistribution is discussed, and the influence on release of Th daughter products to the blood stream and on carcinogenesis is described on the basis of histological studies and the experiences from a group of 842 patients injected with thorotrast and followed for more than 14 years. (82 references.) (auth)

19908 THE GENETIC CONSEQUENCES OF THE EFFECT OF SMALL RADIATION DOSES ON MAN. I. P. Dubinin, M. A. Arsen'eva, and Yu. Ya. Kerkis. p.5-23 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

The natural mutation process in man, mutations caused by the action of ionizing radiation, and the danger from increase in background radiation on the earth are discussed. Analysis of the mutagenic effect of doses in the 05 to 20 r range confirmed experimentally the absence of a threshold dose for mutability. A series of works demonstrated differences in radiogenetic sensitivity in different mammalian species. Experimental results are presented on structural mutations in chromosomes and among other topics the size of the reduplicating dose for fast neutrons is discussed. (OTS)

19909 COMPARATIVE CHARACTERISTICS OF RADIOSENSITIVITY IN DIFFERENT LINES OF MICE IN RELATION TO GENETICS. THE ROLE OF HEREDITARY CHARACTERISTICS IN ANIMAL RADIOSENSITIVITY. N. I. Nuzhdin, N. I. Shapiro, and I. A. Nechaev. p.24-38 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

Radiosensitivity was studied in ca $2\frac{1}{2}$-month-old male and female mice in 4 lines and 1 subline, irradiated with single x-ray doses at 350, 425, 500, 575, and 650 r. Interlinear differences in radiosensitivity were observed. For males $LD_{50/30}$ fluctuated in the range 538 to 413 r and for females in the range of 559 to 465 r. A close similarity in irradiation reaction in intralinear males and females was indicated by the high positive correlation coefficient for LD_{50} values for males and females of a single line determined in interlinear mortality comparisons. The data showed that females were somewhat more resistant than males. $LD_{50/30}$ for males of line S_3NA was 12.8% above that for females, and 3 to 4% for the other lines. Average life duration declined as the dose increased. Interlinear differences in life duration were more pronounced at 350 and 425 r, evening out somewhat as absolute lethal effects were approached. In contrast to males, females showed little interlinear differences in life duration. Comparison of life duration in males and females in 3 lines showed it to be somewhat higher in the former than in the latter at 350 and 425 r. It was good in females at 575 and 650 r. The physiological mechanisms of radiation death in animals of lines differing in radiosensitivity seemed to be uniform. (OTS)

19910 STUDY OF THE CAUSES LEADING TO DISORDERS OF THE OESTRUS IN MICE EXPOSED TO TOTAL BODY RADIATION. N. I. Shapiro, N. I. Nuzhdin, and O. N. Kitaeva. p.180-210 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

Studies were made on the cause of radiation effects on sterility. An attempt was also made to devise an experimental technique for the restoration of the oestrus. Mice were exposed to whole-body irradiation in a dose of 100 r; homogenates of the pituitary glands were then used to carry out the Zondek gonadotrophin reaction on infantile mice and were found to possess the normal gonadotrophic activity. The vaginal epithelium of the irradiated mice gave a normal response to injections of diethylstilatrophybestrol, as shown by vaginal smears. To prove the contention that after-exposure to radiation of the ovarian follicles is the main cause of the oestral disorders, normal ovaries were transplanted into the irradiated mice, whereupon the normal oestrus cycle was restored. If the transplanted ovaries were surgically removed or underwent resorption the cycle again became disrupted. Histological investigation revealed complete absence of follicles and an almost complete lack of corpora lutea in the ovaries of the irradiated mice. The ovaries mainly consisted of stroma whereas the transplanted ovaries showed a normal structure. To establish whether very high doses of gonadotrophic hormone could still produce a response from any residual ovarian tissue in the irradiated ovaries the mice were given 60 mouse units of gonadotrophic hormone. The ovaries and uterus responded with an increase in weight and size but no restoration of the atrophized follicles could be observed. (OTS)

19911 A COMPARATIVE STUDY OF THE EFFECTIVENESS OF SINGLE AND FRACTIONATED X RAY IRRADIATION OF TESTES IN MICE. N. I. Nuzhdin, N. I. Shapiro, M. D. Pomerantseva, and N. N. Kuznetsova. p.115-32 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

To determine the comparative effectiveness of single and fractionated doses of x rays on testes and its relationship to dose size and the degree of fractionation, 3-month-old male mice were whole-body irradiated at 100 r (single dose; 4 × 26 r at 1-day intervals) and 400 r (single dose 2 × 200 r at 4-day intervals; 4 × 100 r at 2-day intervals; 65.5 r for 6 days and 40 r for 10 days). Testes were also locally irradiated at 1600 r (single dose; 4 × 400 r at 2-day and at 4 to 5-day intervals). Spleen, thyroid gland, and leukocytes were also studied to determine the specific reaction of gonads to fractionation. In the 3 series, 491, 111, and 49 animals were studied, respectively, and histological examinations were made of 328 testes. Results showed that cumulative doses of 100 and 400 r caused virtually the same degree of injury to testes whether given singly or fractionated. The somewhat earlier reduction in testes weight and impairment of the germinal epithelium cells followed by more rapid regeneration with a fractionated dose of 400 r was due to the time factor. At 1600 r, however, fractionation reduced injury, showing that the effects of fractionation are influenced by cumulative dose size. At a fractionated dose of 400 r, thyroid gland, spleen, and leukocytes suffered less injury than with a single dose. (OTS)

19912 CONTROL OF THE NATURAL PROCESS OF MUTATION. N. P. Dubinin. p.279-86 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

A review is presented on the problem of natural mutation as well as on ways of influencing the process in the sense of: deliberately increasing the number of mutations by means of the mutagenic effect of radiation, chemicals, and drugs; deliberate changes of the direction taken by the mutations; and suppression of mutations (anti-mutagenic effect). Experiments concerning the antimutagenic effect of streptomycin are described briefly. The substance decreased the frequency of mutations in the chromosomes of Drosophila melanogaster by a factor of 4, and in the chromosomes of onion seedlings by a factor of almost 10. (OTS)

19913 THE PROTECTIVE EFFECT OF CYSTEAMINE (β-MERCAPTOETHYLAMINE) ON CHROMOSOME REORGANIZATION IN THE TISSUES OF MONKEYS AND MICE. N. P. Dubinin, M. A. Arsen'eva, E. S. Kalya'eva, Hsui-ch'uang Ma, and Ang-ch'ih Wang. p.287-99 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

The protective effect of cysteamine against x ray damage in bone marrow and germinal epithelial cell nuclei was studied at the first order spermatocyte stage in mice and monkeys (Macaca mulatta). 2 to 3-month old mice, 25 to 30 g in weight and of the Kun'minsky line, were given 3 mg/150 mg/kg cysteamine intraabdominally, 10 min before irradiation with single doses of 200, 400, and 600 r, at 11.5 r/min. The mice were killed 1, 2, 5, and 10 days later and the testicles and a section of the femur were removed for analysis. Sexually mature, 6 to 8-yr old monkeys received 3 mg/100 mg/kg cysteamine 10 min before irradiation with 200-r doses, were castrated 24 hr later, and a section of a rib was removed. In mice, cysteamine protected the germinal epithelial and bone marrow cells to an average extent of 42.75 and 50.77%, respectively, as compared with controls, and in monkeys, to 52.4 and 50.8%. The monkeys' germinal epithelial cells were much more radiosensitive than those of mice. The theory that radiation-protection is not linked solely to removal of the oxygen effect was supported. In both organs, cysteamine protected against chromosome reorganization but not against chromosome adhesion, which indicates that it acts by forming DNA-cysteamine complexes. (OTS)

19914 THE EFFECT OF SMALL DOSES OF IONIZING RADIATION ON THE FREQUENCY OF OCCURRENCE OF SEX-LINKED, RECESSIVE, LETHAL MUTATIONS IN DROSOPHILA. Ya. L. Glembotskii, E. A. Abeleva, and Yu. A. Lapkin. p.300-11 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

Preliminary results are given of experiments carried out on the effect of 20-r doses of radiation on the frequency of sex-linked, recessive lethals, in relation to: type of radiation—γ rays or high speed neutrons; radiation intensity—single or repeated doses; gamete development—mature sperm or spermatids; and interstrain differences in spontaneous mutation rate. Co^{60} γ rays were delivered at 0.93 r/min. The dose intensity for fast neutrons was 115 r/hr. The results refer only to experiments with D-32 line. It was found that 5-r doses of γ radiation increased the frequency of recessive lethals in sperm and spermatids and repeated radiation produced a cumulative, mutagenic effect. The relative frequency of recessive lethals per radiation induced by repeated 5 r γ radiation agrees with previous data using higher single doses. The mutagenic effect of high-speed neutrons was $1\frac{1}{2}$ to 2 times as great as that of γ rays. Spermatids had a higher mutation rate than sperm, with both types of radiation. No threshold effect was demonstrated and it is suggested that, should a threshold be detected, it will be specific to the type of radiation, type of mutation, stage of gametogenesis, and the organism. The danger to human germinal cells of low doses of γ rays, and especially, high-speed neutrons is stressed. (OTS)

19915 PECULIARITIES OF THE INDUCED MUTATION PROCESS IN MICROORGANISMS. S. I. Alikhanyan, L. I. Yerokhina, and S. I. Lyubinskaya. p.319-32 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

Studies were made on the mechanism of mutation formation in actinomycetes after irradiation with uv, and the effect of visible light on the reactivation of cells inactivated by uv. Aqueous spore suspensions of H-6 Act. olivaceous received doses of 250 to 5000 erg/mm^2 sec from a bactericidal lamp giving resonance radiation with a wavelength of 2537 Å. Visible light was between 3300 to 3600 Å. The constant factor for inactivation was 0.2, for mutagenesis 0.5. Visible light removed the cell inactivation effect and mutagenic effects caused by both high and low doses of uv. The extent of reactivation differed from that of frequency reduction and the processes involved seemed to be independent. To determine the dose of visible light required for maximum reactivation and removal of the mutagenic effect, spores of H-6 Act. olivaceous were subjected to photoreactivation for $\frac{1}{2}$, 1, 2, 4, and 6 hr immediately after radiation. Mutation formation was studied in the biochemical mutant No. 74 Act. olivaceous over a 7-hr period. It was found that only 50% of irradiated spores were reactivated by visible light, and that when spore survival was increased 15,000 times, only 75% of uv-inclined mutations were removed. Two hours were required for visible light to exert its maximum effect on both processes. (OTS)

19916 THE GENETIC EFFECT OF RADIATION IN MICROORGANISMS WITH VARIOUS REORGANIZATIONS OF NUCLEAR STRUCTURES. S. I. Alikhanyan and S. V. Kameneva. p.333-45 of "Radiatsionnaya Genetika." Moscow, Publishing House of the Academy of Sciences, 1962.

The influence of the genotype of an irradiated organism on the effects of radiation was investigated by considering the influence of the genetic effect of irradiation with changing number of nuclear structures in the cell and the effect of gene position in molds of the Penicillium type, whose so-called parasexual cycle enables stable, diploid strains to be obtained. Two diploid groups of mutant strains of P. chrysogenum were used. The number of morphological changes, such as colony size and the total number of mutant and recombined forms in each strain were compared after irradiation with doses of uv (from 250 to 8000 erg/mm^2) and of x rays (5000 to 160,000 r). Antibiotic activity was determined in diploid 16/66 after doses of 2000 and 4000 erg/mm^2. The number of morphological changes was much greater in diploids than in haploids after both uv and x ray irradiation. The influence of the genome on the response of an individual gene to radiation was studied in two double auxotrophic mutants obtained from biochemical mutants of Actinomycetes olivaceous. UV was used in doses of 250, 500, 750, and 1000 erg/mm^2, and x rays in 5×10^3, 10^4, 1.5×10^4, and 2×10^4-r doses. The effect of genome on the reverse mutation at two loci was studied. At one locus, no mutations were found after uv irradiation in strain 80; in the genotypically very similar strain 5, which differs in one newly introduced gene only, a mutation rate of several tenths per 10^9 surviving spores was measured; in strain 19, which differed substantially from strain 80, the mutation rate reached 8 per 10^9 surviving spores at 1000 erg/mm^2. After irradiation with x rays at the same locus, in strain 80 no mutations were observed, in strain 5, 37 per 10^9 surviving spores at 20,000 r, while in strain 19 the frequency declined again. Investigation of the second locus revealed a similar picture. It was concluded that the effect of genotype on postirradiation mutation behavior at a locus and the specificity of behavior at that locus are clearly shown. (OTS)

19917 ON THE LOCALIZATION OF THE EFFECTS OF PENETRATING RADIATION ON THE NERVOUS SYSTEM. D. A. Biryukov. p.118-22 of "Nekotorye Voprosy Sovremennoi Fiziologii." Leningrad, Medgiz, 1959.

Observations were made on brains of various animals irradiated by different methods, and the results, allowing conclusions as to the differing sensitiveness of the various cerebral levels, are presented. Alimentary conditioned motor reflexes in chickens and pigeons were found to persist even after a relatively long protracted penetrating radiation. At the same time, however, considerable alterations were observed in the condition of stem centers. The opticogenic catalepsy of chickens, which is described, is caused by an inhibition that partly develops in the upper cerebral levels, but chiefly in the brain stem. The inhibition is removed by x rays, whereupon the chickens are left in a highly excited state. The effect of aminazine on radiation injuries was examined in 7 chickens. Aminazine (0.001 g/kg of wt) was introduced into the craw and found to remove cataleptic inhibition much like x rays. Since the more striking effects of penetrating radiation under the experimental conditions considered are localized at lower cerebral levels (subcortex in higher animals), the functions of cortex or fore brain are impaired to a lesser degree and are compensated sooner. (OTS)

19918 EFFECTS OF GAMMA RADIATION ON THREE SPECIES OF PHILIPPINE INSECT PESTS. G. B. Viado and E. C. Manoto (Philippine Atomic Energy Commission, National Science Development Board, Manila). IAEA Preprint SM-40/24. 16p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

A study was conducted on the effects of gamma radiation from Co^{60} source on three agricultural insect pests, namely the tomato lady beetle, Epilachna philippinensis Dieke, a pest of tomato and eggplant; the rice weevil, Sitophilus oryza (L.), and the rust-red flour beetle, Tribolium castaneum (Herbst.). The last two species are the most common and most destructive pests of corn and other stored grains and grain products in the Philippines. Eggs, larvae, pupae, and adults of E. philippinensis on tomato and adults of S. oryza and T. castaneum on corn were used. Four doses were used in Epilachna, namely 1, 5, 10, and 20 Kr. In the other two species, five doses were used, 10, 20, 40, 60, and 80 Kr. At 1 Kr, the percentage of unhatched eggs in Epilachna was about 10%. There was no proportionate increase mortality at 5 Kr, but at 10 Kr the mortality increased to more than three times that in the 5 Kr. The mortality at 20 Kr was about 90%. The embryo of eggs which did not hatch failed to continue development. In the larvae, the third and fourth instars were the most susceptible. At 1 Kr the first and second instar larvae were much more susceptible than the fifth instar but at 5 Kr and above they were about the same. All the larvae that survived the treatments above 1 Kr for three weeks died without attaining the pupal stage. The pupae were more resistant than the larvae and the adults. Complete mortality was not attained even with 20 Kr. Some adults which emerged in the 5 Kr and 10 Kr lots had abnormally developed wings and legs. In the adults, the 10 and 20 Kr had adverse effect, killing about 75% of the individuals in the lower and

almost all in the higher dose one week after irradiation. No significant difference in susceptibility between sexes was noted. About 40% of the S. oryza in the lots treated with 60 and 80 Kr were killed one week after irradiation but only about 10% were killed with 20 Kr and about 20% with 40 Kr. The mortality with 40, 60, and 80 Kr increased to about 75% two weeks after the start of the test. The mortality with 10 Kr was less than 10% and that with 20 Kr was about 25%. The threshold dose seems to lie between 20 and 40 Kr. The mortality trend in the T. castaneum was similar to that of the S. oryza, except that the threshold dose seems to lie between 40 and 60 Kr. (auth)

Radiation Sickness

19919 THE PROTECTIVE ACTION OF CERTAIN PHARMACEUTICAL AGENTS IN RADIATION EXPOSURE. Z. Glod. Farm. Polska, 19: 72-4(Feb. 25, 1963).

The general nature of various types of radiation and physiological reactions caused by irradiation are discussed. The terminology used in radiation medicine is defined. The clinical approach to the problem follows two main directions: protection of tissues from the action of primary toxic substances that are generated; and the removal of toxic products from the system. (auth)

19920 THE RADIOPROTECTIVE EFFECTS OF COMBINED HYPOXIA AND AET IN MICE. Leslie M. Zatz (Stanford Univ., Palo Alto, Calif.). Intern. J. Radiation Biol., 6: 105-15(Feb. 1963). (In English)

The radioprotective effects in mice of a combination of hypoxia and AET were studied. No evidence of significant therapeutic synergism was found. A relative increase in the number of deaths which occurred three to six days after irradiation in the protected mice suggested that the protective agents had a selective action on the modes of post-irradiation death. (auth)

19921 PROTECTION OF TISSUE-CULTURE CELLS AGAINST IONIZING RADIATION. III. THE INFLUENCE OF ANOXIA ON THE RADIOPROTECTION OF TISSUE-CULTURE CELLS BY CYSTEAMINE. A. J. Vergroesen, L. Budke, and O. Vos (Medical Biological Lab. RVO-TNO, Rijswijk (Z.H.), Netherlands). Intern. J. Radiation Biol., 6: 117-26(Feb. 1963). (In English)

Using a plating technique of tissue-culture cells, an investigation was done to discover whether the radioprotective action of cysteamine could be explained by means of a hypoxia caused by its autoxidation, or whether another protective mechanism at the cellular level was involved. The protective activity of a 4 and 16 mm cysteamine solution and of anoxia is expressed by dose-reduction factors (DRF) of 1.9, 3.3, and 2.6, respectively. Under anoxic conditions the application of 4 and 16 mm cysteamine solutions resulted in a protection characterized by DRF's of 3 and 3.95. Since a high concentration of cysteamine provided a better protection than anoxia, and cysteamine gave an additional protection under anoxic conditions, it was concluded that the protective action of cysteamine cannot be explained by a hypoxia caused by its autoxidation. Experiments were advised to obtain an intensive contact between air and a thin layer of a cysteamine solution to exclude the possibility of hypoxia. Chemical measurements indicated that cysteamine under this condition is oxidized rather quickly. The protective action of cysteamine in these experiments had a value that might be expected to be produced by the residual concentration of cysteamine present during irradiation. Two hypotheses providing an explanation for the protective action of cysteamine at the cellular level are discussed. (auth)

19922 EXPERIMENTS ON THE RADIOPROTECTIVE ACTION OF DIMETHYL SULPHOXIDE. C. van der Meer, P. W. Valkenburg, and M. Remmelts (National Defence Research Organization TNO, Rijswijk (Z.H.), Netherlands). Intern. J. Radiation Biol., 6: 151-5(Feb. 1963). (In English)

The radioprotective action of dimethyl sulfoxide against a lethal dose of x rays was investigated in two strains of mice. The protection was somewhat better in CBA/Rij than in C57BL/Rij mice. At protective doses a marked fall in the oxygen tension in the spleen was found. This effect was greater in the CBA/Rij than in the C57BL/Rij mice. The intraperitoneal injection of dimethyl sulfoxide caused an abrupt rise in blood pressure lasting only a few minutes. The mechanism of action of dimethyl sulfoxide in the mouse is discussed. (auth)

19923 RADIOPROTECTION BY SULFUR IN THE SUPERMOLECULE $CHI_3 \cdot 3S_8$. Albert van de Vorst and Jules Duchesne (Université, Liege). Intern. J. Radiation Biol., 6: 191-3(Feb. 1963). (In French)

A protective effect of sulfur against x radiation was demonstrated in the supermolecule $CHI_3 \cdot 3S_8$. Possible mechanisms involved are discussed. (C.H.)

19924 INVESTIGATIONS ON THE PROTECTIVE EFFECT OF OLIVE OIL AGAINST X-RAY IRRADIATION OF HAMSTERS. W. Lohmann, W. F. Denny, W. H. Perkins, and A. J. Moss, Jr. (Univ. of Arkansas, Little Rock and Veterans Administration Hospital, Little Rock, Ark.). Intern. J. Radiation Biol., 6: 195(Feb. 1963). (In English)

The injection of olive oil at 10 and 30 min before or after whole-body x irradiation did not change the effect of irradiation on the incorporation of C^{14}-thymidine into desoxyribonucleic acid in hamsters. (C.H.)

19925 EFFECT OF DIFFERENT DIETS ON THE SECRETORY FUNCTION OF THE INTESTINE IN DOGS SUFFERING FROM EXPERIMENTAL RADIATION SICKNESS. M. F. Nesterin. Vopr. Pitaniya, 21: No. 6, 27-33 (1962).

A study was made of the effects of different fats on the secretory function of the digestive glands in dogs irradiated with 400 r and operated with isolated duodenal sections. The diet contained 18% protein, 52% carbohydrates, and 30% fats, such as beef fat, sunflower-seed, cottonseed, or linseed oil. This was given one month before and one month after irradiation. The controls were fed beef fat. After irradiation, the liquid portion of the intestinal juice increased, and from the 9th and 10th day on, lasting in some cases to 10 to 12 weeks. The feeding of unsaturated fatty acids had no influence on these factors. Enrichment of the vegetable oils with 8% of highly unsaturated arachidonic acid reduced both the hypersecretion and the intensity and duration of intestinal hemorrhage; the general reaction to irradiation then became weaker and the rate of survival higher. A daily addition of 25 mg of pyridoxine to linseed oil produced a similar effect while the dogs fed with the control diet showed no reaction to pyridoxine. The ferment content of the intestinal juice changed only when arachidonic acid was given (distinct increase in enterokinase); after irradiation it was not affected by the diet. (OTS)

19926 RADIOINDUCED RADIATION PROTECTION MATERIALS. K. Sommermeyer and H. Magnus (Universitat, Freiburg i. B. and Stadtischen Krankenanstalten, Karls-

ruhe, Ger.). Z. Naturforsch., 18b: 17-23(Jan. 1963). (In German)

If B. coli are irradiated on agar, which was previously irradiated, it was established that in the coli cells there exists an antagonism between the direct radiation and the active materials originating from the agar. The action of the agar under the influence of radioinduced protective materials is comparable with the action of known chemically stable protective materials since they only protect from the results of direct irradiation if they are present in the bacteria before direct irradiation. They possess, in agar, an average lifetime of 30 to 60 sec and in the coli cells, after they are absorbed, they also possess an average lifetime of 30 to 60 sec. (tr-auth)

19927 RADIATION PROTECTION IN URANIUM MINES AND MILLS (CONCENTRATORS). New York, American Standards Association, Inc., 1961. 31p.

Standards are presented for preventing the overexposure of uranium mine and mill workers to whole-body external radiation, ionizing radiation to the lining of the respiratory system, and the accumulation of excessive body burdens of radioisotopes. Maximum permissible doses of radiation are reviewed and protective measures and equipment are described. (C.H.)

CHEMISTRY

General and Miscellaneous

Refer also to abstract 19723.

19928 (GEAP-4201) ACCURATE NUCLEAR FUEL BURNUP ANALYSES. Fifth Quarterly Progress Report, December 1962–February 1963. B. F. Rider, C. P. Ruiz, and J. P. Peterson, Jr. (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Mar. 1, 1963. Contract AT(04-3)189. 32p.

The development of accurate methods for determination of nuclear fuel burnup is discussed. Foils of U^{233}, U^{235}, and Pu^{239} were irradiated in MTR and are being irradiated in VBWR in order to measure relative fission yields of specific fission products for those isotopes. In order to measure relative fission yields of the same fission products in Th^{232} and U^{238}, capsules are being made to contain cadmium oxide covered UO_2 and ThO_2 for irradiation in VBWR. A four column separations scheme was developed for separation of stable fission product neodymium from irradiated UO_2. The first column of Dowex-2 is used to remove bulk quantities of U and Pu to prevent overloading of later columns. The second column of D2EHP-VYNS is used to remove Ce-144 activity. The third column of D2EHP-VYNS is used to isolate neodymium by reversed phase partition chromatography. The final column of Dowex-50 removes traces of actinides. Equations and their derivations are presented for Nd calculations. (auth)

19929 (UCRL-7160) HIGH-PRESSURE EQUATION OF STATE BIBLIOGRAPHY AND INDEX (1925–1962). Stephen G. Brush, Rose Kraft, and Jean Senkin (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 22, 1963. Contract W-7405-eng-48. 208p.

About 1500 references on the equation of state of materials at high pressure are presented. These are listed chronologically; each citation is accompanied by descriptors listing the materials or theories investigated. The descriptors were indexed alphabetically according to the "keyword" system. The indexing is more complete for elements, inorganic compounds, minerals, and explosives than for organic compounds and composite materials. Most mixtures were excluded. For gases, "high pressure" was taken to mean pressures above 50 atm, or virial coefficients higher than the second; but for liquids and solids, all compressibility measurements were included when found. Topics such as shock-wave compression, melting curves, quantum theory of the electron gas, and Thomas-Fermi theory were also included. (auth)

19930 SYNTHESIS OF o-PHOSPHONOBENZENEAZOCHROMOTROPIC ACID AS A NEW REAGENT AND ITS THORIUM COMPLEX. Haruo Miyata (Okayama Univ., Japan). Bull. Chem. Soc. Japan, 36: 127-8(Jan. 1963). (In English)

The synthesis of o-phosphonobenzeneazochromotropic acid from o-bromobenzenediazonium fluoborate is described. The absorption spectra of the reagent and of a 1:2 mixture of the reagent and thorium were measured at various pH values. The reagent has a maximum in the region of 510 mμ, while that of the thorium complex falls at 555 mμ. The complex was found to have a reagent:thorium ratio of 1:1. (D.L.C.)

19931 COPRECIPITATION OF SCANDIUM WITH CALCIUM OXALATE. Tsunenobu Shigematsu, Masayuki Tabushi, and Masakazu Matsui (Shigematsu Lab., [Japan]). Bull. Inst. Chem. Res., Kyoto Univ., 40: 381-7(Nov. 1962). (In English)

The coprecipitation of Sc with Ca as oxalate was studied. Precipitation of Ca was carried out in a homogeneous precipitation system, in which dimethyl oxalate was decomposed to form oxalate ion. Homogeneous and logarithmic distribution coefficients were obtained by measuring radioactivity of Sc^{46} used as a tracer, and by the chelatometric titration of Ca. Logarithmic distribution was followed at pH 2.0 ~ 3.5, whereas near pH 4 homogeneous distribution was obeyed. It was optimum for the enrichment of Sc that Ca be precipitated at about 80°C at pH 2.5 to 3.0, and the precipitate be filtered after 2 or 3 hours. (auth)

19932 LUMINESCENCE OF THE URANYL–PHTHALOCYANINE COMPLEX. G. N. Lyalin and G. I. Kobyshev. Dokl. Akad. Nauk SSSR, 148: 1053-6(Feb. 11, 1963). (In Russian)

The luminescence of the uranyl complex with the tetrapyrrol pigment phthalocyanine (Ptc), which forms luminescent complexes with many divalent cations, was investigated. The presence of a complex was indicated by the difference between the electron absorption and luminescence spectra of solutions of uranyl Ptc and those of H_2Ptc in dioxane. The maxima did not depend on the solvent (77°K). The intensity of the luminescence of UO_2Ptc decreased at 77°K and increased when the temperature was raised. The phenomenon was completely reversible. Although the temperature dependence of the luminescence of UO_2Ptc was unusual, that of H_2Ptc and of MgPtc was not. The fine-line structure of the UO_2Ptc complex spectrum in nonane differed significantly from the H_2Ptc in the distribution of intensity between lines and in the significantly greater intensity of lines at 684 mμ. A nonane solution containing a drop of UO_2Ptc solution in dioxane showed short-wave maxima, which were not observed for a solution without metal. The presence of at least two luminescing centers in the UO_2Ptc complex was shown by the dependence of the luminescence spectra on the wavelength of the exciting light. (TTT)

19933 PERIODICITY OF THE ISOTOPIC EXCHANGE REACTION IN DIATOMIC MOLECULES. A. M. Rozen and A. I. Mikhailichenko (Mendeleev Inst. of Chemical Tech., Moscow). Dokl. Akad. Nauk SSSR, 148: 1133-6 (Feb. 11, 1963). (In Russian)

The relation, originally developed by J. Biegeleisen and M. Mayer (J. Chem. Phys. 15: 26(147)), the so-called β-factors, was found to be useful for calculating the separation coefficients in isotopic exchange reactions. The correlation of the β-factors on the atomic number was examined by determining the frequency of oscillation of diatomic molecules, including hydrides and Li^{6-7} fluorides, chlorides, bromides, and iodides. The expressions derived indicate a dependence of the β-factors not only on the filling of the electron shells but also on the internuclear distances. In view of the periodic nature of the variation of internuclear distances of diatomic hydrides, the increase of the distance results in a diminution of the β-factor. The derived equations are valid for all monovalent elements. (TTT)

19934 THERMAL REDOX REACTIONS BETWEEN METAL IONS AND RADICALS IN AQUEOUS SOLUTIONS. E. Collinson, F. S. Dainton, B. Mile, S. Tazuke, and D. R. Smith (Univ. of Leeds, Eng.). Nature, 198: 26-30(Apr. 6, 1963).

Thermal redox reactions between metal ions and radicals in aqueous solutions were investigated. Results are reported from measurements of rate constants for reactions involved in the x or γ irradiation of aqueous solutions of acrylamide containing a metallic compound. Systems with Fe III, Cu II, Ti III, Ag I, Hg II, and Eu II were used. Reactions involved in the oxidation of polyacrylamide radicals, the reduction of polyacrylamide radicals, the oxidation of hydrogen atoms, the reduction of hydroxyl radicals, and the effects of the metal ions on reactions in aqueous solutions are discussed. (C.H.)

19935 HIGHER IONISATION POTENTIALS IN ALCOHOLS AND WATER MEASURED BY ELECTRON IMPACT. H. Sjoegren and E. Lindholm (Royal Inst. of Tech., Stockholm). Phys. Letters, 4: 85-8(Mar. 15, 1963). (In English)

Monoenergetic electrons were used to study the higher ionization potentials of polyatomic molecules without mass spectrometric analysis. The higher ionization potentials were measured for water, CH_3OH, and C_2H_5OH. (C.E.S.)

19936 ORTHO AND PARATRITIUM. Edwin W. Albers, Paul Harteck, and Robert R. Reeves, Jr. (Rensselaer Polytechnic Inst., Troy, N. Y.). Z. Naturforsch., 18a: 197-202 (Feb. 1963). (In English)

Normal tritium was partially and totally converted to paratritium by adsorption on charcoal at liquid neon and liquid helium temperature. The experimentation was performed with 300 millicuries of tritium sealed in a small glass apparatus where the transformation could be performed and the paratritium concentration measured by thermal conductivity. In the adsorbed phase the conversion half life was one minute, about 24 times faster than normal hydrogen. In the solid phase the conversion half life was in the order of 15 minutes. Both processes were much faster than expected. (auth)

19937 THE ZERO POINT ENERGIES OF ISOTOPIC HOMOLOGUES AND ISOMERS. Jacob Bigeleisen (Brookhaven National Lab., Upton, N. Y. and Eidgenossische Technische Hochschule, Zurich) and Paul Goldstein. Z. Naturforsch., 18a: 205-9(Feb. 1963). (In English)

An explicit formula was derived for the zero-point energy of a system of coupled harmonic oscillators. It is shown that for the case of isotopic homologs this leads to an approximate linear relation in the number of equivalent isotopic substituents. It is shown that the zero-point energy differences of successive members of an isotopic homologous series increases with further substitution of the heavy isotope. Through a study of the parabolic deviations from the linear rule, it is shown that intermediate members of an isotopic homologous series form a better basis for interpolation and extrapolation than the end members. The appropriate intermediate members are given by the second order sum rule. (auth)

19938 NOTE ON THE CALCULATION OF ZERO-POINT ENERGIES AND ISOTOPIC ZERO-POINT ENERGY DIFFERENCES BY A TAYLOR'S SERIES EXPANSION. J. Bigeleisen, R. E. Weston, Jr., and M. Wolfsberg (Brookhaven National Lab., Upton, N. Y.). Z. Naturforsch., 18a: 210-15(Feb. 1963). (BNL-6550). (In English)

The series expansion for the zero-point energy of a system of harmonic oscillators derived by Bigeleisen and Goldstein was examined. The convergence properties were tested as a function of the reduced frequency, and the error produced in truncating the series was found. Calculations of zero-point energy sums by solving the secular equations for isotopically substituted series of hydrogen, methane, ethylene, ethane, and benzene molecules were made and the results are discussed in terms of the first- and second-order isotope sum rules. (auth)

Analytical Procedures

19939 (IA-756) SELF-SHIELDING EFFECTS IN ACTIVATION ANALYSIS. J. Gilat and Y. Gurfinkel (Israel. Atomic Energy Commission, Rehovoth). Dec. 1962. 24p.

A quantitative approach to the problem of self-shielding in activation analysis is presented. Self-shielding correction factors were evaluated analytically for spheres, infinite slabs, and infinitely long solid cylinders. An interpolative process is proposed for the case of a finite solid cylinder. Scattering of neutrons inside the sample being activated is dealt with in detail. The conditions prevailing in neutron activation analysis are discussed, as are deviations from the true correction factors. (auth)

19940 (IA-799) RADIOACTIVATION ANALYSIS OF SODIUM BY COUNTING PHOTONEUTRONS. S. Amiel and M. Peisach (Israel. Atomic Energy Commission, Rehovoth). Feb. 1963. 28p.

A nondestructive radioactivation analysis method for Na in complex matrices is described, in which Na^{24} is assayed by counting photoneutrons emitted from deuterium by the 2.75-Mev gamma ray, in an assembly consisting of D_2O and neutron detectors. The principle offers efficient discrimination against large amounts of radioactivities with energies below 2.23 Mev, the threshold for the photodisintegration of deuterium. The photoneutron activity was found to be proportional to the Na^{24} content and microgram quantities of Na were analyzed with a precision of 2%. Sensitivities better than 0.1 μg are indicated. Interference from other radionuclides and the possible extension of the analysis to elements other than Na are discussed. (auth)

19941 (ORNL-TM-523) GAS CHROMATOGRAPHIC ANALYSIS OF BIPHENYL PYROLYTIC PRODUCTS. L. B. Yeatts, Jr., J. E. Attrill, and W. T. Rainey, Jr. (Oak Ridge National Lab., Tenn.). Mar. 13, 1963. Contract [W-7405-eng-26]. 41p.

Gas chromatographic procedures are presented for the quantitative determination of three hydrocarbon fractions obtained from the pyrolysis of biphenyl. The low molecular weight hydrocarbons, hydrogen, and carbon monoxide were resolved on a column of silica gel in series with a molecular sieve (Linde 5A) column. The sensitivity, expressed in recorder scale divisions per μl, of the peak height measurements for the various gases was found to be: hydrogen, 1.72; methane, 24.6; carbon monoxide, 28.4; ethane, 25.8; ethylene, 14.7; propane, 18.0; and propylene, 5.58. The benzene fraction was analyzed with a column of 30 wt % Apiezon L plus 2 wt % Carbowax 20M on Chromosorb P. The analytical precision of the peak area determinations was ±2% over the range of 35 to 170 μg of benzene. Through the use of temperature programming, the polyphenyl compounds were determined utilizing a stationary phase of 20 wt % LiCl on Chromosorb P. The peak area measurements of the terphenyl isomers were reproducible within ±2%, in general, for 10 to 120 μg of material. The precision of the quaterphenyl data was also ±2% for 40 to 210 μg of the isomers. (auth)

19942 (PG-Report-157) ANALYTICAL METHOD FOR THE SPECTROGRAPHIC DETERMINATION OF GENERAL METALS AND RARE EARTH ELEMENTS IN RESIDUES (IRON FLUX METHOD). (United Kingdom Atomic Energy Authority. Production Group, Springfields, Lancs, England). 1963. 25p.

A method for the determination of general metals and rare earth elements in residues by the iron flux method is applicable to any type of sample that can be converted to an oxide, or to certain residues that can be ground. The sample in the form of a dry residue is mixed with iron flux. Pellets of the resultant dilutions are spectrographed between Cu electrodes using a d-c arc aligned with a large quartz Littrow-type spectrograph. The spectra are evaluated by visual methods using Fe as internal standard. Elements that can be determined are Al, Ba, Be, Bi, Ca, Cr, Co, Pb, Mg, Mn, Mo, Ni, Si, Sr, Sn, Ti, V, W, Zn, Ce, Dy, Eu, Gd, Ho, La, Lu, Nd, Pr, Sm, Sc, Tb, Yb, Y, Er, and Tm. The method is also applicable to the determination of Be between 0.01 and 0.0005% with respect to residue by amendments to the spectrographic procedure. (P.C.H.)

19943 (TID-18411) THE DEVELOPMENT OF KRYPTON AS A UNIVERSAL TRACER. Quarterly Report, November 1, 1962–January 31, 1963. (Parametrics, Inc., Waltham, Mass.). Contract AT(30-1)-2757. 15p.

The use of Kr^{85} as an indicator in different titrations was studied. The advantages of kryptonates along with several titration results are given. The apparatus used is also described. (P.C.H.)

19944 (UCRL-7165) A CONTROLLED-POTENTIAL COULOMETER. F. B. Stephens and J. E. Harrar (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 21, 1963. Contract W-7405-eng-48. 14p.

A controlled-potential coulometer, which combines a previously designed solid-state potentiostat with a vacuum tube integrator circuit, was developed for routine use. The instrument features a simple, direct readout circuit, which permits visual presentation on a digital voltmeter of the amount in milligrams of substance reduced or oxidized. Circuit operation, calibration procedure, and use in analyses are described. Performance in analysis of uranium and hydrogen peroxide is presented. (auth)

19945 DETERMINATION OF HISTIDINE DECARBOXYLASE ACTIVITY BY LIQUID SCINTILLATION COUNTING OF $C^{14}O_2$. Yutaka Kobayashi (Worcester Foundation for Experimental Biology, Shrewsbury, Mass.). Anal. Biochem., 5: 284-90(Apr. 1963).

A simple and rapid method for the determination of histidine decarboxylase activity by liquid scintillation counting of $C^{14}O_2$ is described. Radioactive CO_2 produced by carboxyl-labeled L-histidine is trapped by aqueous Hyamine hydroxide spread on filter paper edged with paraffin wax. The radioactive Hyamine carbonate is assayed in a liquid scintillation counter. The method can detect the decarboxylation of 0.001 μg L-histidine. (P.C.H.)

19946 REVIEW OF APPLICATIONS ANALYSIS. FOOD. Emanuel Borker and Katherine G. Sloman (General Foods Technical Center, White Plains, N. Y.). Anal. Chem., 35: 62R-77R(Apr. 1963).

Advances in food analysis are reviewed. Discussion is included on: additives; adulteration, contamination, and decomposition; carbohydrates; color; enzymes; fats, oils, and fatty acids; flavors and volatile compounds; inorganic constituents; moisture; organic acids; proteins, amino acids, and nitrogen; and vitamins. 658 references are given to U. S. and foreign journals published from October 1960 to October 1962. (P.C.H.)

19947 REVIEW OF APPLICATIONS ANALYSIS. FERROUS METALLURGY. H. F. Beeghly and L. C. Pasztor (Jones and Laughlin Steel Corp., Pittsburgh). Anal. Chem., 35: 88R-96R(Apr. 1963).

A review is given on the analysis of ferrous alloys. 348 references are given to U. S. and foreign journals published from November 1960 through June 1962. (P.C.H.)

19948 REVIEW OF APPLICATIONS ANALYSIS. NONFERROUS METALLURGY. Frits Will, III and M. L. Moss (Aluminum Co. of America, New Kensington, Penna.). Anal. Chem., 35: 96R-105R(Apr. 1963).

A review is given on nonferrous metallurgical analysis. Special attention is given to new methodology on analysis of the light structural metals: Al, Be, Mg, and Ti. 187 references are given to U. S. and foreign journals published from September 1960 through August 1962. (P.C.H.)

19949 REVIEW OF APPLICATIONS ANALYSIS. WATER ANALYSIS. M. W. Skougstad and M. J. Fishman (Geological Survey, Denver). Anal. Chem., 35: 179R-204R (Apr. 1963).

A review is given on methods and techniques in the analytical chemistry of water. Radioactivity and isotopic analysis are also included. 514 references are given to U. S. and foreign journals published from August 1960 through September 1962. (P.C.H.)

19950 DETERMINATION OF TECHNETIUM BY CONTROLLED-POTENTIAL COULOMETRIC TITRATION IN BUFFERED SODIUM TRIPOLYPHOSPHATE MEDIUM. A. A. Terry and H. E. Zittel (Oak Ridge National Lab., Tenn.). Anal. Chem., 35: 614-18(May 1963).

A controlled-potential coulometric method for the determination of Tc was developed whereby Tc(VII) is titrated in an acetate-buffered (pH 4.7) solution of sodium tripolyphosphate at a potential of −0.70 volt vs S.C.E. In the range from about 0.5 to 5 mg of Tc(VII) titrated, the relative error of the method is about ±1% and the relative standard deviation about 0.5%. Various possible interferences were studied; Tc(VII) can be removed quantitatively from most interfering ions by distillation from sulfuric acid solution. The method is relatively simple and rapid. (auth)

19951 ESTIMATION OF MERCURY IN BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION ANALYSIS. Hamilton Smith (Glasgow Univ.) and Western Regional Hospital Board, Glasgow). Anal. Chem., 35: 635-6(May 1963).

Neutron activation analysis combined with chemical separation is a quick, accurate method for the estimation of Hg in small samples of biological materials. After nitric–sulfuric acid digestion of the activated sample, a precipitation separation is combined with a gravimetric yield determination. The activity is detected by scintillation counting. (auth)

19952 SPECTROPHOTOMETRIC DETERMINATION OF TUNGSTEN IN NUCLEAR MATERIALS AND STEELS BY EXTRACTION WITH 8-QUINOLINOL. Allan R. Eberle (New Brunswick Lab., N. J.). Anal. Chem., 35: 669-73 (May 1963).

A spectrophotometric method for the determination of W in Zr, zircaloy, U, Be, and steels by extraction with 8-quinolinol–chloroform is described. The procedure involves the preliminary extraction of interfering Mo from hydrofluoric acid solution, addition of boric acid, and extraction of the W from the solution adjusted to pH 2.0. Interferences in the final chloroform extract are removed

with ammonium sulfate–sulfuric acid washings. Large amounts of Co and V, as found in certain types of stainless steels, interfere, but these elements are removed by a rapid cation exchange separation prior to the extraction of Mo and W. Slight modifications in the procedure are necessary for the analysis of Be. Nb and Ta are among the many elements that do not interfere. The results are reproducible and the agreement with standard samples tested is good. The method is more rapid and precise than existing methods. (auth)

19953 PHOTOMETRIC TITRATION OF BERYLLIUM. T. M. Florence and Yvonne J. Farrar (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Anal. Chem., 35: 712-14(May 1963).

A new method for the titrimetric determination of Be in diverse materials is described. The sample is treated with a known excess of sodium sulfosalicylate, then back-titrated with standard beryllium sulfate solution using a simple, commercially available photometric titrator. The reaction between Be and sulfosalicylate is stoichiometric (1 to 2), the end point being detected with arsenazo indicator at pH 10.6. The interference of most elements is prevented by the addition of (1,2-cyclohexylenedinitrilo)-tetracetic acid (CyDTA). Uranium may be masked with H_2O_2, and Cr can be tolerated if oxidized to the hexavalent state. The range of the titration is 0.05 to 15 mg of Be, with a relative standard deviation of ±0.13% at the 3-mg Be level, and 0.37% at the 0.8-mg Be level. (auth)

19954 SEPARATION OF AMERICIUM FROM OTHER ELEMENTS: APPLICATION TO THE PURIFICATION AND RADIOCHEMICAL DETERMINATION OF AMERICIUM. Fletcher L. Moore (Oak Ridge National Lab., Tenn.). Anal. Chem., 35: 715-22(May 1963).

A new, simple analytical radiochemical method for the determination of Am tracer involves the Ag-catalyzed peroxydisulfate oxidation of trivalent Am to the sexivalent state. Fluoride stabilizes the americyl ion during a series of La fluoride scavenges. Excellent separation of Am tracer is effected from Cm, Bk, Cf, Pu, U, Th, Cs, Sr, Zr, Nb, Ru, Fe, Al, and lanthanide elements. Several useful analytical and process applications of the efficient purification method are discussed. (auth)

19955 DETERMINATION OF TOTAL RADIOSTRONTIUM IN BIOLOGICAL SAMPLES CONTAINING LARGE QUANTITIES OF CALCIUM. SELECTIVE PRECIPITATION WITH POTASSIUM RHODIZONATE. A. L. Boni (E. I. du Pont de Nemours & Co., Inc., Aiken, S. C.). Anal. Chem., 35: 744-7(May 1963).

Improved recovery of total radiostrontium from biological samples containing large quantities of Ca was attained through the use of potassium rhodizonate as a selective precipitating agent. An analytical procedure utilizing the method was developed, and optimum conditions for an 85% chemical recovery were determined. An over-all recovery of 72% (with a standard deviation of ±9 at the 90% confidence level) was obtained for 2-g bone samples. (auth)

19956 RADIOCHEMICAL DETERMINATION OF ACTINIUM IN URANIUM MILL EFFLUENTS. Henry G. Petrow and Robert J. Allen (Ionics Inc., Cambridge, Mass.). Anal. Chem., 35: 747-9(May 1963).

The determination of Ac in U mill effluents requires an accurate, sensitive method, free of interference from the host of impurities, both stable and radioactive, likely to be present. The method described is sensitive to low concentrations, less than 60 dpm per liter, is free from interference from likely contaminants, and has a relative error of about ±5%. The radioassay of Ac is accomplished by following the in-growth rate of α-emitting daughters. (auth)

19957 ESTIMATION OF STRONTIUM-84 IN BIOLOGICAL MATERIAL BY NEUTRON ACTIVATION ANALYSIS. Hamilton Smith (Glasgow Univ. and Western Regional Hospital Board, Glasgow). Anal. Chem., 35: 749-51(May 1963).

Neutron activation analysis combined with chemical separation and scintillation spectrometry is a quick, accurate method for the estimation of added Sr^{84} in biological materials. After nitric acid digestion of the activated sample, a precipitation separation is combined with a gravimetric yield determination. The activity is detected by counting over a limited γ-energy range. (auth)

19958 DETERMINATION OF TOTAL SULFUR IN WATER BY NEUTRON ACTIVATION ANALYSIS. Cooper H. Wayman (Geological Survey, Denver). Anal. Chem., 35: 768-9(May 1963).

A method for the determination of total S in H_2O by neutron activation analysis is presented. Sulfur lends itself to determination by neutron activation analysis by virtue of its radioactive properties of being a weak beta-emitter with an activation cross section of 10.9 mb for a half life of 87.1 days. As little as 0.01 ppm of S can be detected in water, provided Cl and P have been removed to eliminate interferences from the $P^{31}(n,\gamma)P^{32}$ and $Cl^{35}(n,\alpha)P^{32}$ reactions. The most sensitive reaction for determining S is $S^{32}(n,p)P^{32}$. (P.C.H.)

19959 A SCHEME FOR THE ANALYSIS OF MONAZITE AND MONAZITE CONCENTRATES. K. S. Chung and J. P. Riley (Univ. of Liverpool). Anal. Chim. Acta, 28: 1-29 (Jan. 1963). (In English)

A scheme using ion-exchange methods is described for the analysis of monazites and monazite concentrates. The sample is opened up with concentrated sulphuric acid, and the resultant solution is applied to a column of Zeocarb 225 resin. After phosphate has been washed out, lead, aluminum, titanium, iron, uranium, calcium, and magnesium are eluted with N hydrochloric acid and determined by specific, mainly spectrophotometric, methods. Rare earth elements are eluted with 3N hydrochloric acid. Cerium is separated from the other rare earths by solvent extraction of its nitrate with methyl-iso-butyl ketone; both groups are determined gravimetrically. Thorium is eluted from the ion-exchange resin with 3.6N sulphuric acid and determined spectrophotometrically with thorin. The sulphuric acid-insoluble minerals are brought into solution by a double fusion method, and the determinations are carried out by a combination of ion-exchange and photometric procedures. Silica, phosphorus pentoxide, tin, and chromium are determined by photometric methods, using separate portions of the sample. Lanthanum, yttrium, and ytterbium are determined in a 1M perchloric acid solution of the mixed rare earth oxides (less cerium) using flame photometry. Samarium, praseodymium, and neodymium are determined by spectrophotometry. (auth)

19960 DETERMINATION OF ZIRCONIUM AND HAFNIUM WITH XYLENOL ORANGE AND METHYLTHYMOL BLUE. K. L. Cheng (RCA Labs., Princeton, N. J.). Anal. Chim. Acta, 28: 41-53(Jan. 1963). (In English)

Both Xylenol Orange and Methylthymol Blue are highly selective and sensitive reagents for zirconium and hafnium forming intensely red complexes in an acidic medium. The factors affecting the color formation were studied. The

properties of the complex were determined and compared. In general, zirconium forms a more stable complex with the two dyes than hafnium, and Xylenol Orange forms a stronger complex with either zirconium or hafnium than Methylthymol Blue. Hydrogen peroxide can completely mask the zirconium complexes of either dye but only slightly affects the hafnium complex of Xylenol Orange. Zirconium and hafnium can both be determined without separation using peroxide as a masking agent and sulfate as a demasking agent. A bleaching reaction was observed when small amounts of hafnium were added to the red zirconium complex of Methylthymol Blue in 2.4N perchloric acid or a small amount of zirconium was added to the red hafnium complex of Methylthymol Blue solution at pH 2 to 3. (auth)

19961 DETERMINATION OF CADMIUM IN URANIUM BY ION EXCHANGE AND SQUARE-WAVE POLAROGRAPHY. Fumito Nakashima (Hitachi Ltd., Hitachi City, Japan). Anal. Chim. Acta, 28: 54-60(Jan. 1963). (In English)

Traces of cadmium in uranium and its compounds can be determined by ion-exchange separation and square-wave polarography. With a small column of anion-exchange resin, cadmium can be separated from uranium and recovered quantitatively from hydrochloric acid solution. Separations of cadmium from uranium are not perfect but are sufficient for the determination of traces of cadmium by square-wave polarography. The lower limit of the method is 0.01 ppm of cadmium. (auth)

19962 COLOUR REACTION OF SCANDIUM WITH QUERCETIN AND ITS APPLICATION TO THE ANALYSIS OF SCANDIUM. Hiroshi Hamaguchi, Rokuro Kuroda, Ryuitiro Sugista, Naoki Onuma, and Tsuneo Shimizu (Tokyo Univ.). Anal. Chim. Acta, 28: 61-7(Jan. 1963). (In English)

A spectrophotometric study of the scandium–quercetin complex is described; μg amounts of scandium can be determined with quercetin at 435 mμ and pH 4.4. A 1:1 complex is formed. The apparent instability constant of the complex was estimated as $2.7 \cdot 10^{-7}$ by a spectrophotometric method. An ion-exchange method for separating scandium from several interfering ions is described. (auth)

19963 THE WET CHEMICAL ANALYSIS OF CERTAIN IMPURITIES IN HIGH-PURITY BERYLLIUM. Eugene N. Pollock and Lawrence P. Zopatti (Nuclear Metals, Inc., Concord, Mass.). Anal. Chim. Acta, 28: 68-77(Jan. 1963). (In English)

Photometric methods for the analysis of iron, nickel, copper, aluminum, silicon, chromium, and manganese in high-purity beryllium are described. (auth)

19964 THE APPLICATION OF MICROCHEMICAL METHODS TO RADIOCHEMICAL ANALYSIS. PART III. SOLVENT EXTRACTION OF DIETHYLDITHIOCARBAMATES AND THE RADIOCHEMICAL SEPARATION AND PURIFICATION OF COBALT, NICKEL, PALLADIUM, SILVER AND CADMIUM. R. G. Monk (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Anal. Chim. Acta, 28: 217-26(Mar. 1963). (In English)

The advantages of solvent extraction of diethyldithiocarbamates in radiochemical separations are discussed. The development of a procedure for the separation and purification of cobalt and nickel from mixtures containing fission products is described; diethyldithiocarbamate extraction is used extensively. A scheme incorporating this procedure is also described whereby the fission products palladium, cadmium, and silver are also determined on the same sample. (auth)

19965 SPECTROPHOTOMETRIC DETERMINATION OF SCANDIUM WITH ANTHRARUFIN-2,6-DISULFONIC ACID (DISODIUM SALT). John C. MacDonald and John H. Yoe (Univ. of Virginia, Charlottesville). Anal. Chim. Acta, 28: 264-70(Mar. 1963). (In English)

A new spectrophotometric method for the determination of scandium is described using anthrarufin-2,6-disulfonic acid (disodium salt) as a reagent. The color reaction has a sensitivity of 0.004 μg Sc per cm^2 for $\log I_0/I = 0.001$ and obeys Beer's law up to 2 ppm. The effects of pH, time, order of addition of the reagents, temperature, and diverse ions were investigated. A separation procedure was developed and applied to six salt solutions containing scandium plus a variety of foreign ions. (auth)

19966 A COMBINED ANION EXCHANGE-SOLVENT EXTRACTION PROCEDURE FOR SEPARATING TRACE AMOUNTS OF Eu, Gd, Dy, Sm AND Er FROM THORIUM TETRAFLUORIDE. R. A. Edge (Univ. of Cape Town, South Africa). Anal. Chim. Acta, 28: 278-81(Mar. 1963). (In English)

A combined anion exchange-solvent extraction procedure was developed to facilitate the spectrographic determination of trace quantities of Eu, Gd, Dy, Sm, and Er in thorium tetrafluoride. (auth)

19967 DETERMINATION OF TITANIUM AND ZIRCONIUM AND THEIR SEPARATION FROM EACH OTHER WITH CHELIDONIC ACID. A. K. Majumdar and S. P. Bag (Jadavpur Univ., Calcutta). Anal. Chim. Acta, 28: 293-5 (Mar. 1963). (In English)

Chelidonic acid reacts with Ti, Zr, Th, and rare earths and is suitable for the separation and gravimetric determination of Ti and Zr. H_2O_2 is used to keep Ti in solution while Zr is precipitated. The Zr complex may be weighed as $ZrO(C_7H_2O_6) \cdot H_2O$ or ignited and weighed as the oxide, while the Ti complex is of indefinite composition and should be ignited. (D.L.C.)

19968 POLAROGRAPHY OF URANIUM IN LACTATE MEDIUM. S. C. Saraiya and A. K. Sundaram (Atomic Energy Establishment, Trombay, India). Anal. Chim. Acta, 28: 360-5(Apr. 1963). (In English)

The polarography of uranium(VI) in the lactate medium is studied at different pH values. At pH 1 the half-wave potential of the uranium(VI) wave remains the same as that of the simple ion, but the limiting current increases with increasing concentration of lactate; disproportionation of uranium(V) at the electrode surface is suggested. The rate of disproportionation is calculated. Polarograms observed in the region of pH 5 and 6 are interpreted on the basis of complexation of UO_2^{2+}. (auth)

19969 ANALYTICAL APPLICATIONS OF INFRARED SPECTROSCOPY. THE BEHAVIOUR OF THE OXINATES OF NIOBIUM, TANTALUM AND ASSOCIATED ELEMENTS. Robert J. Magee and Ian Martin (Queen's Univ., Belfast). Anal. Chim. Acta, 28: 366-70(Apr. 1963). (In English)

The behavior of the oxinates of niobium, tantalum, and associated metals in the infrared region was studied, and a method was developed for the determination of niobium and tantalum. Vanadium caused no interference, but other heavy metals, such as molybdenum, manganese, and cobalt, which interfered were removed by preliminary treatment when the method was applied to the determination of niobium and tantalum in steels. (auth)

19970 SPECTROPHOTOMETRIC DETERMINATION OF RARE EARTH METALS WITH 1-(2-PYRIDYLAZO)-2-NAPHTHOL. Shozo Shibata (Government Industrial Research Inst., Nagoya, Japan). Anal. Chim. Acta, 28: 388-92(Apr. 1963). (In English)

1-(2-Pyridylazo)-2-naphthol (PAN) reacts very sensitively with rare earth metals to form a deep red precipitate in alkaline solution; this can be extracted with ether, except in the case of lanthanum, cerium, and scandium. Absorption maxima occur at 530 and 560 mμ. Traces of rare earth metals may be determined in the presence of many foreign metals. (auth)

19971 THE SPECTROPHOTOMETRIC DETERMINATION OF SOME ORGANIC ACIDS WITH COPPER BENZIDINE. Zorica D. Draganić (Boris Kidrich Inst. of Nuclear Sciences, Vinča, Yugoslavia). Anal. Chim. Acta, 28: 394-7(Apr. 1963). (In English)

The copper-benzidine method can be used for the analysis of irradiated aqueous solutions for microgram quantities of organic acids. The absorption spectra and temperature coefficients on the reaction products are tabulated and plotted. The presence of H_2O_2 in concentrations smaller than 0.01 M does not affect the accuracy, but the method cannot be used easily for simultaneous determinations. (D.L.C.)

19972 SPECTROGRAPHIC DETERMINATION OF TRACE AMOUNTS OF RARE EARTHS. I. ANALYSIS OF LANTHANUM AND YTTRIUM BY THE POWDER SIFTING METHOD. Z. Radwan, B. Strzyzewska, and J. Mincewski (Inst. of Nuclear Research, Warsaw). Appl. Spectry., 17: 1-5(1963).

A new simplified method for the determination of trace amounts of rare earths in HCl and sodium versenate solutions was developed. Solutions of the rare earths, La and Y, and of the internal standard (palladium chloride) were evaporated on graphite powder, and mixed with NH_4NO_3. Vertically arranged Cu electrodes were used with the sifter electrode as the cathode and a flat surfaced Cu rod as the anode. A generator was used as excitation source, which combines a d-c arc with a Feussner spark. The excitation was effected in an atmosphere of 20% Ar and 80% O. The detection limit obtained for the two elements, La and Y, as chlorides and as versenates was 0.2 and 0.1 μg per sample respectively. The usual range of the method was from 0.5 to 10 μg/ml for either solution and element. The average coefficient of variation for the method was ±13.7%. The mutual interferences of both elements were considered as negligible for the range of concentration investigated. (auth)

19973 "IN SITU" GAMMA SPECTROMETRY OF SEA WATER AND OF ALLUVIAL MUDS IN THE CHANNEL (MEASUREMENTS MADE ON BOARD THE OCEANOGRAPHIC SHIP "THALASSA" IN MAY 1961). R. Chesselet and D. Nordemann. Bull. Inform. Sci. Tech. (Paris), No. 64, 37-45(Aug.-Sept. 1962). (In French)

"In situ" gamma spectrometry is a method for the direct detection and counting of natural or artificial gamma-emitting nuclei in sea water. Application of the method during recent experiments on board the O. V. Thalassa in the Channel (May 1961) are discussed. The performances of the equipment are known: the yield for a gamma emitter uniformly distributed in an infinite medium surrounding the detector is 34 counts/hr/pC/l (photoelectric detection of K^{40}). Sensitivity is estimated at 5 pC/l. The gamma spectra obtained are analyzed. (auth)

19974 DIBENZOYLMETHANE AS A CHELATING REAGENT IN SOLVENT EXTRACTION AND SPECTROPHOTOMETRIC DETERMINATION. Tsunenobu Shigematsu, Masayuki Tabushi, and Tsunenhiko Tarumoto (Shigematsu Lab., [Japan]). Bull. Inst. Chem. Res., Kyoto Univ., 40: 388-99(Nov. 1962). (In English)

Solvent extraction of ferric iron, U, Be, Cu, Ni, Co, and Zn as chelates with dibenzoylmethane was studied using butyl acetate or chloroform as an extracting solvent. The spectrophotometric determination of Fe and U using this method was also investigated. Quantitative extraction can be obtained at pH 2 to 3 for Fe, pH 5 to 9 for U, Be, and Cu, pH 8 to 10 for Ni, pH 9 to 10 for Zn, and near pH 10 for Co. Among these metals, U and Be are extracted even in the presence of EDTA. With the information on the extraction behaviors of these metal chelates, the methods for the separation of U and Be from fission products, the separation of Fe from Cu, Ni, and Co, and the separation of Cu from Ni and Co were examined. Crystals of ferric- and uranyl chelate were prepared and the compositions were estimated to be $Fe(C_{15}H_{11}O_2)_3$ and $UO_2(C_{15}H_{11}O_2)_2$. Ferric- and uranyl chelates in organic solvent exhibit absorption bands in and near ultraviolet region, and the maxima at 410 mμ of Fe and 400 mμ of U can be used for the spectrophotometric determination. Beer's law is obeyed up to 2 ppm of Fe and 10 ppm of U. Molar extinction coefficient of Fe is 17,000 1/M cm at 410 mμ and of U 20,300 1/M cm at 400 mμ and 17,680 1/M cm at 410 mμ. By the analytical procedure proposed, 0.00003–0.0001% of Fe in Ni, Co, and Zn salt was successfully determined. (auth)

19975 DETERMINATION OF NEUTRON-PRODUCED GASES IN BERYLLIUM BY GAS CHROMATOGRAPHY. L. W. Hillen and M. Thackray (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). J. Chromatog., 10: 309-13(Mar. 1963). (In English)

Gases present in Be after neutron irradiation were extracted by vacuum melting. The He and H content of the extracted gas was determined by gas chromatography and the results compared with those obtained by mass spectrometry. It was found that the gas chromatographic results can be obtained more cheaply and rapidly than those using the mass spectrometer and are less liable to error. When using gas chromatography alone, the entire sample can be diluted with Ar to a pressure that makes the effect of the sampling valve leak negligible. (P.C.H.)

19976 ELECTRON MICROSCOPIC AUTORADIOGRAPHY OF RADIOIODINE IN THE THYROID USING THE EXTRANUCLEAR ELECTRONS OF I^{125}. Jack Kayes, Arvid B. Maunsbach, and Sven Ullberg (Karolinska Institutet, Stockholm). J. Ultrastruct. Res., 7: 339-45(Oct. 1962).

An electron microscopic autoradiographic technique is described for study of iodine distribution in the thyroid. The radiation source used is low-energy conversion electrons and the Auger electrons of I^{125} with energies of about 3 and 30 kev. Other advantages of I^{125} compared with I^{131} are high resolution, reduced risk of radiation damage, and longer half life (60 days for I^{125}, 8 days for I^{131}). Ultrathin tissue sections were coated with Ilford G5 and Ilford K2 emulsions. Ultrastructural details in the sections were recognized although no attempt was made to remove remaining gelatin. A ratio of 25 : 1 was found between the number of Ag grains over the colloid and of Ag grains over comparable areas of thyroid cells. The size of reduced Ag grains over the colloid average 0.33 ± 0.07 μ. Since the Ag grains are so large, it was concluded that one important factor limiting the autoradiographic resolution is the size of the developed Ag grains. (TCO)

19977 MICRODETERMINATION OF SILVER IN METALLIC URANIUM BY THE ANODIC STRIPPING COULOMETRY. Takayoshi Yoshimori, Tsugihiko Yamada, Tsutomu Hongo, and Tsugio Takeuchi (Gifu Univ., Nako-cho, Japan). Kogyo Kagaku Zasshi, 65: 1808-11(Nov. 1962).

Trace amounts of Ag in metallic U were determined by anodic stripping coulometry. For samples containing less than 0.4 ppm Ag, Ag was separated from U by coprecipitation with thallous iodide; then the precipitate was dissolved with a sulfuric acid–hydrogen peroxide mixture. The solution was evaporated to dryness, and Ag was determined by anodic stripping coulometry. For samples containing more than 0.4 ppm Ag, it could be determined in the presence of the large amount of U without preliminary separation. In the latter case, the effect of U was suppressed by formation of citrate complex. Satisfactory results were obtained by both methods. The effects of volume and pH of the electrolyte solution were also studied. For 10 ml of the electrolyte solution, 80-min electrodeposition was advisable, where 0.1 to 2 μg Ag was to be determined. For 20 ml, 3-hr electrodeposition was advisable, where 0.3 to 2 μg Ag was to be determined. Variation of pH (3 to 7) of the electrolyte did not influence the dissolution curve area. (H.H.D.)

19978 TECHNIQUES OF HIGH-TEMPERATURE X-RAY DIFFRACTION USING METAL RIBBON FURNACES. Deane K. Smith (Univ. of California, Livermore). Norelco Reptr., 10: 19-29(Jan.-Mar. 1963). (UCRL-6935)

The ribbon element x-ray diffractometer furnace is shown to have several advantages over more common resistance element designs. The most outstanding feature of the design is the maximum temperatures, which can be reached in various atmospheres. Physical properties of some of the elements used as heater materials are discussed with respect to heater performance. The techniques used in construction of the heaters are described. Problems involved in accurate measurement of temperature are discussed. Several calibration techniques that have been used successfully are described. The accuracy of temperature determinations is demonstrated by comparing measured thermal expansion values with data reported in the literature. The techniques of sample preparation are discussed in detail because of their importance in obtaining good data. Several examples are presented to point out the need of careful sample preparation and show the quality of data that can be obtained. (P.C.H.)

19979 ACTIVATION ANALYSIS OF SILICON DIOXIDE. A. I. Kalinin, R. A. Kuznetsov, and V. V. Moiseev. Radiokhimiya, 4: 575-81(1962). (In Russian)

The activation method was used for determining As, Au, Co, Cu, Cd, Ga, In, Mo, Sb, Sn, Ta, W, and Zn in silicon dioxide. Ion exchange chromatography was used for separation of the activated admixtures. Ion exchange chromatography proved to be efficient for separating radiochemically pure elements. (R.V.J.)

19980 APPLICATION OF α EMISSION FOR DETERMINING CERTAIN ELEMENTS IN SOLUTION AND IN SOLID SUSPENSION. I. N. Plaksin, M. A. Belyakov, V. L. Rentyrgin, and L. P. Starchik. Radiokhimiya, 4: 581-7(1962). (In Russian)

Nuclear (α,n) reaction with Po^{210} α emitter was used for determining Be, B, F, and Al. (R.V.J.)

19981 APPLICATIONS OF CHLOROPHOSPHONAZO (III) IN PHOTOMETRIC DETERMINATION OF PENTAVALENT ACTINIDE ELEMENTS. I. DETERMINATION OF NEPTUNIUM. E. G. Chudinov and G. N. Yakovlev. Radiokhimiya, 4: 601-5(1962). (In Russian)

The reaction of Np(V) with chlorophosphonazo III (3,6-bis[(4-chloro-2-phosphonophenyl)azo]-4,5-dihydroxy-2,7-naphthalenedisulfonic acid was studied. Molar absorption coefficient in photometric determination of Np(V) with the reagent is 58,600 at 672 mμ. It is shown that Np(V) and chlorophosphonazo(III) are in 1:1 ratio, with an instability constant 4.0×10^{-6}. Using masking substances neptunium can be determined without preliminary separation. (R.V.J.)

19982 APPLICATION OF CHLOROPHOSPHONAZO (III) FOR PHOTOMETRIC DETERMINATION OF PENTAVALENT ACTINIDE ELEMENTS. II. DETERMINATION OF PROTACTINIUM. E. G. Chudinov and G. N. Yakovlev. Radiokhimiya, 4: 605-6(1962). (In Russian)

Reaction of protactinium solution 2.99×10^{-4} M in 0.1 n HCl containing 0.01 M NH_4F with chlorophosphonazo(III) (3,6-bis[(4-chloro-2-phosphonophenyl)azo]-4,5-dihydroxy-2,7-naphthalenedisulfonic acid) resulted in a blue-green compound. The absorption curves of chlorophosphonazo (III) with Pa(V) are constructed and the maximum absorptions for Pa compounds are found at 630 and 688 mμ. The Pa compound spectrum is closer to the Np(IV) and Th(IV) spectra than to Np(V) and U(VI). The experiments indicate that arsenazo III and chlorophosphonazo III behave identically. (R.V.J.)

19983 ADVANCES IN APPLICATIONS OF THE ARSENAZO-THORIN GROUP OF REAGENTS IN ANALYTICAL CHEMISTRY. S. B. Savvin (Vernadskii Inst. of Geochemistry and Analytical Chemistry, Moscow). Usp. Khim., 32: 195-219(Feb. 1963). (In Russian)

A review is given of properties and applications of reagents of the arsenazo-thoron group. Methods for determining Th, U, Zr, Pu, Np, Am, Sc, Be, Al, In, V, Nb, Ta, Ti, Li, Ba, Sr, Bi, sulfates and F are discussed. (217 references) (R.V.J.)

19984 STUDIES OF COMPLEX FORMATION IN ZIRCONIUM–SELENENOYL–ACETONE–BENZENE–WATER SYSTEM BY THE METHOD OF DISTRIBUTION. N. V. Mel'chakova and V. M. Peshkova. Vestn. Mosk. Univ., Ser. II, Khim., No. 6, 61-3(Nov.-Dec. 1962). (In Russian)

Complex formation in the zirconium–selenenoyl acetone–benzene–water system was studied using the distribution method. Purified Zr^{95} was used for determining equilibrium zirconium concentrations in two phases. A distribution curve of zirconium–selenenoyl-acetone stability constants were constructed and data are tabulated. (R.V.J.)

19985 TRACE ANALYSIS OF Cu IN ZnS PHOSPHORS BY MEANS OF NEUTRON ACTIVATION. I. Broser and K.-H. Franke (Institut für Elektronenmikroskopie am Fritz-Haber-Institut, Berlin and Max-Planck-Gesellschaft, Berlin). Z. Physik, 172: 520-9(1963). (In German)

The applicability of neutron activation analysis to the determination of copper impurities in ZnS was investigated. The sensitivity of the method was determined, and the method of chemical separation, which is necessary after irradiating the samples, is outlined. Because of the disturbing nuclear reaction $Zn^{64}(n,p)Cu^{64}$ the sensitivity of the method does not only depend on the absolute amount of copper atoms available but also on the concentration of Cu in zinc sulfide. Using a thermal neutron flux of 3×10^{11} cm^{-2} sec^{-1}, a ratio of thermal to resonance flux (gold) $\Phi_{th}/\Theta = 30$ and a copper concentration of 1×10^{-4} g Cu/g ZnS, it is possible to determine amounts of Cu as small as 3×10^{-8} g. Increasing the neutron flux improves the sensitivity of the analysis. Increased moderation of the neutron flux makes the analysis of ZnS with smaller copper contents possible (limiting value when using the Berlin Reactor BER: 5×10^{-7} g Cu/g ZnS, with $\Phi_{th}/\Theta = 8000$). (auth)

19986 ANALITICHESKAYA KHIMIYA RUTENIYA. (Analytical Chemistry of Ruthenium). T. D. Avtokratova.

Moscow, Publishing House of the Academy of Sciences, 1962. 265p.

Physico-chemical and analytical characteristics of Ru and Ru compounds are described. Various methods for Ru determination in various elements, ores, and minerals are discussed. A supplement on Ru determination in fluorides is included. 784 references are given. (R.V.J.)

19987 NEW SPECTROPHOTOMETRIC METHODS FOR THE DETERMINATION OF SCANDIUM, YTTRIUM, AND BROMATE. John Chisholm MacDonald. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 112p.

New spectrophotometric methods for the determination of scandium, yttrium, and bromate, respectively, have been developed. Scandium and yttrium react non-selectively with anthrarufin-2,6-disulfonic acid (disodium salt) to give one to one complexes which obey Beer's law. The sensitivity of the scandium reaction is one part in 250 million and that for yttrium is one part in 200 million. Ion exchange with Dowex-1 X 8 and solvent extraction with dibutyl phosphate, tributyl phosphate, and thenoyltrifluoroacetone were investigated. Separation procedures were developed for scandium and yttrium. The scandium separation procedure was successfully applied to six salt solutions containing various trace amounts of this element. Bromate reacts with o-arsanilic acid to give a reddish-brown color. This reaction, though somewhat unstable, was developed into a spectrophotometric method for traces of bromate. The method is sensitive to one part of bromate in 20 million parts of solution. The effects of pH, time, and temperature are critical and must be carefully controlled. (A.G.W.)

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Refer also to abstracts 20408, 20409, 20968, 20974, 20975, 20976, 20977, and 20978.

19988 (AD-290792) LITHIUM HYDRIDES. [Period Covered], 1958–November 1962. (Armed Services Technical Information Agency, Arlington, Va.). 18p.

A bibliography with abstracts on lithium hydrides is presented. Thirty-two items are included. (J.R.D.)

19989 (AD-299972) DISSOLUTION POTENTIALS OF BERYLLIUM IN SOME MINERAL ACIDS. Technical Report No. 1. M. E. Straumanis and D. S. Gnanamuthu (Missouri. Univ., Rolla. School of Mines and Metallurgy). Feb. 1963. Contract Nonr-2296(03). 20p.

Dissolution potential (ϵ')–time, ϵ'–acid concentration, and ϵ'–current density curves were obtained for Be dissolving in dilute HF, HCl, $HClO_4$, and H_2SO_4 at about 30°C. The potential increased (became more noble) with time in HF and H_2SO_4; in HCl and $HClO_4$ the potentials changed only slightly with time. The potential increased with increasing concentration of the acids only in HF; there was a pronounced decrease in HCl, $HClO_4$, and H_2SO_4. The potential increased linearly in all cases with current density, although in HF the measurements were very erratic. The most active values were obtained in HF (0.05 N) with the sample containing the smaller amount of oxygen: about −1.15 volt (hydrogen scale); the least active–in H_2SO_4 (0.02 N): about −0.23 volt. The small change in ϵ' with time and the downward trend of the ϵ'–acid concentration curves can be regarded as a symptom of disintegration of the dissolving anode. The ϵ'–current density curves do not suggest a possible disintegration of Be. (auth)

19990 (IS-517) FLAME SPECTRA OF VANADIUM, NIOBIUM, RHENIUM, TITANIUM AND MOLYBDENUM. Velmer A. Fassel, Robert B. Myers, and Richard N. Kniseley (Ames Lab., Ames, Iowa). [July 23, 1962]. Contract [W-7405-eng-82]. 22p.

Line spectra of V, Nb, Ti, Mo, and Re of sufficient intensity to allow detection if the 1-to-10-ppm level can be excited in fuel-rich, oxy-acetylene flames. Recordings of the spectra are given along with the wavelengths of the strongest lines. (auth)

19991 (NP-12680) ENGINEERING PROPERTIES OF POTASSIUM. Quarterly Report No. 5, October 1–December 31, 1961. Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 30, 1962. Contract NAS-5-584. 13p.

Activities in a program directed to determining the thermodynamic and transport properties of K at 900 to 2100°F are reported. Efforts during the period were devoted mostly to preparation for research. A stainless steel boiling tube suitable for use at 1500°F was prepared and filled with K. In a program to measure the specific heat of liquid K to 2100°F measurements above 775°C are in question because of the K condensing effect inside the closed capsule. In other work, design of a capillary-flow-type viscometer for K vapor measurements at 900 to 2100°F was completed. Fabrication of a 1-liter Nb–Zr bomb for measuring K-vapor compressibility is also reported. (J.R.D.)

19992 (NP-12689) ENGINEERING PROPERTIES OF POTASSIUM. Quarterly Report No. 9, October 1–December 31, 1962. Alexis W. Lemmon, Jr. (Battelle Memorial Inst., Columbus, Ohio). Jan. 30, 1963. Contract NAS-5-584. 14p.

Measurements of the viscosity, vapor pressure, and enthalpy of liquid K were concluded. Thermal conductivity and electrical resistivity was measured up to about 800°C; the apparatus is being modified so that measurements can be continued up to 1150°C as planned. The P-V-T equipment is being calibrated and checked; measurements should be completed in about another month. The design study of equipment for the direct determination of the specific heat of K vapor was concluded. A decision was reached that the most favorable method for measuring the thermal conductivity of K vapor is a dynamic method in which a barewire probe is used; apparatus design is continuing. Final equations for the enthalpy and specific heat of solid and liquid K as well as a value for the heat of fusion (14.30 cal/g) are reported. The equations are H_t (solid) = $0.1705\ t + 0.2095 \times 10^{-3}\ t^2$ (0 to 63.2°C), H_t (liquid) = $13.453 + 0.20070\ t - 0.45421 \times 10^{-4}\ t^2 + 0.38019 \times 10^{-7}\ t^3$ (63.2 to 1150°C), C_s (solid) = $0.1705 + 0.4190 \times 10^{-3}\ t$ (0 to 63.2°C), C_s (liquid) = $0.2004 - 0.8777 \times 10^{-4}\ t + 1.0970 \times 10^{-7}\ t^2$ (63.2 to 1150°C). Enthalpies and specific heats show excellent agreement with work of previous investigators below 800°C. Thermal conductivity and electrical resistivity of liquid K were measured to about 800°C, and tentative values were previously reported. Modification of the heat sink of the apparatus to permit measurements to 1150°C is now being made. Since the failure previously reported, parts of the vapor viscometer were reconstructed. The last of four tests designed to determine the adequacy of the furnace atmosphere were successful, and K was charged to the boiler to begin operation. Activity during the quarter on the vapor compressibility (P-V-T) apparatus was that of assembly, testing, and calibration. It was determined that the dynamic probe method offers the best possibility for the accurate measurement of the thermal conductivity of K vapor. Data on electrical

conductivity of the vapor indicate that it is much lower than expected, and thus a bare wire probe may be satisfactory. Design of apparatus is continuing. (auth)

19993 (TID-18460) INFORMATION ON BONDING IN XENON COMPOUNDS FROM INFRARED SPECTRA. D. F. Smith (Oak Ridge Gaseous Diffusion Plant, Tenn.). [1963]. Contract [W-7405-eng-26]. 14p.

Infrared spectra were obtained for XeF_2, XeF_4, XeF_6, $XeOF_4$, and XeO_3. Information on the chemical bonding of these compounds as derived from their spectra is presented. (J.R.D.)

19994 (AEC-tr-5732) PREPARATION OF BORON TRIFLUORIDE. G. M. Panchenkov and A. V. Makarov. Translated by A. L. Monks (Oak Ridge National Lab., Tenn.) from Vestn. Mosk. Univ., Ser. II: Khim., No. 1, 3-6(1963). 5p.

Two procedures are given for the preparation of BF_3 under laboratory conditions: $6NH_4BF_4 + B_2O_3 + 6H_2SO_4 \rightarrow 6NH_4HSO_4 + 8BF_3 + 3H_2O$ and $C_6H_5N_2BF_4 \rightarrow C_6H_5F + N_2 + BF_3$. The first method can be used to produce sufficient amounts of rather pure BF_3 (with an SiF_4 content of the order of 1%). The second can be used to obtain slight amounts of very pure BF_3 (with an SiF_4 content less than 0.1%). (P.C.H.)

19995 PRELIMINARY X-RAY STUDY ON THE DIOXANE ADDITION COMPOUNDS OF HYDRATED RARE EARTH PERCHLORATES. William G. R. de Camargo and J. V. Valarelli (Universidade, São Paulo, Brazil). Acta Cryst., 16: 321-2(Apr. 10, 1963).

The crystallographic properties of hydrated rare earth perchlorates are described. The general chemical formula is $M(ClO_4)_3 \cdot 9H_2O \cdot 4C_4H_8O_2$, with M = La, Ce, Pr, Nd, and Sm. Values for the unit cell dimensions, cell volumes, densities, and optical constants are tabulated. (P.C.H.)

19996 INTERATOMIC DISTANCES IN URANIUM CARBIDES. Brahama and D. Sharma (Univ. of Southern California, Los Angeles). Acta Cryst., 16: 322-3(Apr. 10, 1963).

The calculation of bond numbers associated with each interatomic distance observed, and the valences of both uranium and carbon in UC, U_2C_3, and UC_2, is presented. The calculations were made using two values of $R_1(U)$, namely, 1.421 and 1.45 Å. The valence of U found was well below the expected value of 6.0 in all three carbides. The valence of U in UC and U_2C_3 was 3 and that for UC_2 was nearly 4. Data are tabulated. (P.C.H.)

19997 TRACER INSOLUBILITY AND THE ANOMALOUS DIFFUSION OF RARE EARTHS IN SILVER AND LEAD. G. P. Williams, Jr. (Wake Forest Coll., Winston-Salem, N. C.) and L. Slifkin. Acta Met., 11: 319-22(May 1963).

Tracers of Ce, Nd, and Pm were diffused into single and polycrystals of silver and lead. The penetration plots consist of two regions: (a) a steep segment near the surface, corresponding to diffusion coefficients of the order of 10^{-12} to 10^{-13} cm^2/sec even at temperatures near the melting point; and (b) a deep segment, corresponding to diffusion coefficients of the order of 10^{-9} to 10^{-11} cm^2/sec. The deep segment is very structure-sensitive and thus cannot be associated with volume diffusion. Observations similar to these have been reported for other systems, all of which are characterized for negligible solubility of the tracer in the host crystal. (auth)

19998 DIFFUSION OF IRON, COBALT AND NICKEL IN SILVER. Ken-ichi Hirano (Tohoku Univ., Sendai), Morris Cohen, and B. L. Averbach. Acta Met., 11: 463-6 (May 1963).

Diffusion coefficients of iron, cobalt, and nickel in silver were determined over the temperature range 600 to 850°C using radioactive tracers and the residual-activity technique. The results are as follows (in units of cm^2/sec): $D_{Fe/Ag} = 9.4 \times 10^{-7}$ exp (–29,600/RT), $D_{Co/Ag} = 3.0 \times 10^{-7}$ exp (–29,700/RT), and $D_{Ni/Ag} = 8.5 \times 10^{-7}$ exp (–28,700/RT). The frequency factors and activation energies are quite small relative to those for self-diffusion in silver. It appears that the extremely low solid solubilities of iron, cobalt, and nickel in silver reduce the flux through the lattice to the point where diffusion along dislocation short-circuiting paths becomes the controlling mechanism. This is in line with the diffusion results previously obtained for these tracer elements in aluminum. (auth)

19999 INVESTIGATION OF THE DIELECTRIC PROPERTIES OF LEAD ZIRCONATE. S. Gluecksman (Academy of Mining and Metallurgy, Krakow). Acta Physiol. Polon., 13: 397-406(Mar. 1963). (In English)

The effect of aging, of a strong external d-c electric field, of the measuring current frequency, and of irradiation with fast and slow neutrons on the dielectric properties of PbZrO samples was investigated. (auth)

20000 ALKALI HALIDE SOLID SOLUTIONS. I. PROPERTIES OF PURE COMPONENTS. Jaakko Hietala (Univ. of Helsinki, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, 121: 1-17(1963). (In English)

Notation and formulas concerning pure alkali halides are given. Carefully selected experimental values of pertinent physical properties are tabulated. Particular attention was devoted to thermal expansion coefficients and compressibilities as well as to their derivatives with respect to temperature. (auth)

20001 ALKALI HALIDE SOLID SOLUTIONS. II. HEAT OF FORMATION OF THE SODIUM CHLORIDE TYPE. Jaakko Hietala (Univ. of Helsinki, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, 122: 1-31(1963). (In English)

A theory of heat of formation of solid solutions of the sodium chloride type is presented. It is shown that from both the static and thermodynamic angles the experimental values are represented with reasonable precision by a simple second-degree parabola when described as a function of crystal composition. The residual energetic asymmetry was treated separately. (auth)

20002 A STABLE CHELATE OF 2,4-DIAMINO-6-PHENYL-s-TRIAZINE. C. E. Meloan and J. Butel (Kansas State Univ., Manhattan). Anal. Chem., 35: 768(May 1963).

2,4-Diamino-6-phenyl-s-triazine (benzoguanamine) was screened for chelating ability with a variety of metals. Only Cu^{2+} showed any real indication of forming a chelate. The stability constant for the Cu^{2+} system was found to be 2.5×10^{-5} at an ionic strength of 0.1 at 25°C. The pK values for protonating the ligand were found to be 2.9 and 4.3 also at an ionic strength of 0.1 at 25°C. (P.C.H.)

20003 THE PRODUCTS FROM THE REACTION OF GASEOUS URANIUM HEXAFLUORIDE WITH SOLID URANIUM TETRAFLUORIDE. Hoang Nguyen-Nghi, (Centre d'Etudes Nucleaires, Saclay, France), Pierre Plurien, Baggioni-Escoubes, and Charles Eyraud. Bull. Soc. Chim. France, No. 1, 72-3(Jan. 1963). (In French)

Above 100°C, the reaction of gaseous UF_6 with solid UF_4 leads to the intermediate fluorides already announced in the literature: $\alpha-UF_5$, $\beta-UF_5$, U_2F_9, U_4F_{17}. Below 100°C, the formation of U_4F_{17} and U_2F_9 does not occur as was reported by Broadley and Longton. The products obtained can be considered as nonstoichiometric compounds of UF_4. (tr-auth)

20004 X-RAY POWDER CRYSTALLOGRAPHIC DATA ON PLUTONIUM OXALATES AND THEIR ISOMORPHS. I. L. Jenkins, F. H. Moore, and M. J. Waterman (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Chem. Ind. (London), No. 1, 35-6(Jan. 5, 1963).

X-ray powder crystallographic data are presented for the plutonium(III) and (IV) oxalates, including $Pu_2(C_2O_4)_3 \cdot 10H_2O$ and $PuO_2C_2O_4 \cdot 3H_2O$. In the course of a study of the stoichiometry of plutonium(IV) oxalate, a hitherto unknown dihydrate was prepared in addition to the well-known hexahydrate. $Pu(C_2O_4)_2 \cdot 2H_2O$ was shown to be isomorphous with $U(C_2O_4)_2 \cdot 2H_2O$ and with $Th(C_2O_4)_2 \cdot 2H_2O$, and $Pu(C_2O_4)_2 \cdot 6H_2O$ to be isomorphous with $U(C_2O_4)_2 \cdot 6H_2O$. Methods of preparation are given in detail for: $Pu_2(C_2O_4)_3 \cdot 10H_2O$, $Pu(C_2O_4)_2 \cdot 6H_2O$, $Pu(C_2O_4)_2 \cdot 2H_2O$, and $PuO_2C_2O_4 \cdot 3H_2O$. When freshly precipitated $Pu(C_2O_4)_2 \cdot 6H_2O$ or $Pu(C_2O_4)_2 \cdot 2H_2O$ is shaken repeatedly with acetone, a bright pink acetone complex, $Pu(C_2O_4)_2 \cdot 2H_2O \cdot x(CH_3)_2CO$ (isomorphous with its uranium(IV) analog $U(C_2O_4)_2 \cdot 2H_2O \cdot x(CH_3)_2CO$) is formed. The U and Pu complexes containing acetone are unstable and lose acetone on standing, the final product being the U or Pu oxalate dihydrate. On the basis of the x-ray crystallographic data, unit-cell dimensions for the Pu compounds and for their U and Th analogs are tabulated. (H.H.D.)

20005 THE DETERMINATION OF THE DIFFUSION COEFFICIENTS OF OXYGEN IN THE ZIRCONIUM–OXYGEN SYSTEM. Jean Debuigne and Pierre Lehr (CNRS, Paris). Compt. Rend., 256: 1113-16(Jan. 28, 1963). (In French)

The results of the experimental determination of the diffusion coefficients of oxygen in Zr and its oxide system are given. The scheme used for the study is shown, and the results obtained are presented graphically. (J.S.R.)

20006 THE ELECTRIC CONDUCTIVITY OF A SINTERED MIXTURE OF 87% ZrO_2–13% La_2O_3 BETWEEN 1200 AND 1650°C. Anne-Marie Anthony and Jean Renon (CNRS, Bellevue, France). Compt. Rend., 256: 1718-21 (Feb. 18, 1963). (In French)

The electric conductivity of a sintered compart of 87% ZrO_2–13% La_2O_3 was measured between 1200 and 1650°C. The results showed that the log of the conductivity as a function of 1/T°K is divided into three distinct line segments corresponding to the temperature intervals 1200 to 1400°C, 1400 to 1525°C, and above 1525°C. Measurements under varying oxygen pressures showed that in the first segment the conductivity obeys the law $\sigma = 1.1 \exp(-0.69/kT)$, where k is the Boltzmann constant and T is the absolute temperature. The conductivity is of the semiconductor type caused by the appearance of Schottky and Frenkel faults. Above 1400°C the conductivity is expressed by $\sigma = 7 \times 10^2 \exp(-1.50/kT)$. Type n semi-conductivity is present. Above 1525°C, the conductivity is given by $\sigma = 4 \times 10^4 \exp(-2.38/kT)$. (J.S.R.)

20007 THE REACTION OF CARBON MONOXIDE ON URANIUM. Jean Besson, Guy Féron, and Claude Moreau (CEN, Grenoble, France). Compt. Rend., 256: 1780-3 (Feb. 18, 1963). (In French)

The reaction of CO with U powder leads to an almost equimolecular mixture of the dicarbide, UC_2, and the dioxide, UO_2. The speed of this reaction increases rapidly up to 730°C, then remains almost constant. The kinetics cannot be determined by the Valensi-Carter method. (tr-auth)

20008 THE TELLURIDES L_2Te_4 AND L_2Te_3 OF THE RARE EARTH ELEMENTS HAVING THE THORIUM PHOSPHIDE Th_3P_4 CRYSTALLINE TYPE. Marie-Paule Pardo, Jean Flahaut, and Louis Domange. Compt. Rend., 256: 1793-6(Feb. 18, 1963). (In French)

The first five elements of the rare earth series (La, Ce, Pr, Nd, and Sm) from tellurides with the formula $LTe_{1.33}$ that have the thorium phosphide Th_3P_4 structure. Gd, Dy, and Y do not form definite compounds of this type. Cerium appears in the compound as a trivalent ion. In Sm_3Te_4, there are two trivalent and one divalent Sm ions. La, Pr, and Nd tellurides behave differently from Ce_3Te_4. For La, Ce, and Pr, there are phases of the Th_3P_4 type for the composition $LTe_{1.5}$. Nd_2Te_3 and Gd_2Te_3 have a crystalline structure different from that of Th_3P_4, but it has not been identified. The simultaneous existence of Sm^{2+} and Sm^{3+} causes a linear variation of the crystalline parameters as a function of the composition in the entire solid solution region. (J.S.R.)

20009 A NIOBIUM TELLURIDE, $NbTe_2$. Marcel Chaigneau and Monique Santarromana (CNRS, Paris). Compt. Rend., 256: 1797-9(Feb. 18, 1963). (In French)

The preparation of $NbTe_2$ is described. Some of its chemical and physical properties are studied. (tr-auth)

20010 CONTRIBUTION OF SPECIFIC HEAT MEASUREMENTS BELOW 4°K TO THE OBSERVATION OF HELIUM DIFFUSION AFTER ANNEALING IN IRRADIATED BERYLLIUM OXIDE. J. Aslanian and L. Weil (Centre de Recherches sur les Très Basses Temperatures, Grenoble, France). Cryogenics, 3: 36-9(Mar. 1963).

Helium atoms resulting from fast neutron reactions in BeO remain dissolved in the material, and it is necessary to anneal the samples in order to have them precipitate as bubbles. The helium in irradiated BeO is studied through measurements of specific heat at low temperatures. At a given temperature small bubbles appear through precipitation of helium atoms at the beginning of an annealing. The specific heat measurement method may be exploited in a quantitative manner to obtain a better understanding of helium diffusion in oxides on metals. (C.E.S.)

20011 DYNAMICAL POLARIZATION OF PROTONS IN SOME POLYMERS USING THE SOLID EFFECT METHOD. J. Burget, M. Odehnal, V. Petříček, and J. Šácha (Nuclear Research Inst., Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 12: 911-18(1962). (In English)

Experimental results on the dynamical polarization of protons in various polymers irradiated by neutrons are recapitulated. The measurements were performed at liquid nitrogen temperatures. The polarization dependence on the microwave power, on the irradiation dose, and on the change in frequency of the nuclear magnetic resonance was investigated. The maximum enhancement of polarization was obtained for polyethylene of a density ~0.95 g/cm^3 and was equal to 30. (auth)

20012 EXCITATION OF ELECTROLUMINESCENCE IN ALKALI HALIDE COMPOUNDS. A. N. Georgobiani, N. P. Golubeva, and P. N. Lebedev (Moscow Inst. of Physics). Czech. J. Phys., 13: 91-3(1963). (In English)

In ionic crystals the concentration of free carriers and the mean free path are usually small and the forbidden band is large. The field energy is in the main spent on heating the crystal. Therefore, it is difficult to accelerate an appreciable number of electrons to the energy necessary for the excitation of electroluminescence. These difficulties can be overcome by removing a thin layer of the luminophore. With the decrease in the layer thickness the development of the cascade breakdown becomes more difficult, and the thermal exchange with the electrodes becomes

better. This makes it possible to increase the field up to the values necessary for tunnel ionization of the luminescence centers. Electroluminescence of the sublimated layer of CsI-Tl was found. (auth)

20013 POLYMORPHISM OF COMPOUNDS OF THE TYPE $RENbTiO_6$. A. I. Komkov. Dokl. Akad. Nauk SSSR, 148: 1182-3(Feb. 11, 1963). (In Russian)

In order to determine the possibility of polymorphism, compounds of the $RENbTiO_2$ (where RE = rare earth) type, obtained hydrothermally at 250 to 300°C from $RE_2O_3-Nb_2O_5-2TiO_2$ mixtures, were calcined in air at temperatures of 300 to 1300°C and higher. With rare earths of atomic number from 64 to 71 (Gd, Tb, Dy, Er, Tm, Yb, and Lu), besides the alpha modification isostructural with the eschynite-priorite minerals, D_{2h}^{16} = Pbnm, there was another modification, referred to as beta, isostructural with the euxenite-polycrase minerals, D_{2h}^{14} = Pcan. The alpha, or low-temperature, type was formed at 250 to 300°C, and the beta, or high-temperature, type at 750 to 950°C. Both types contained four formula units in the elementary nucleus. For compounds containing rare earths of atomic number from 57 to 63 (La, Ce, Pr, Nd, Sm, Eu) the beta form was not detected, even at 1300°C or higher. The compound $EuNbTiO_6$ began to decompose at temperatures near its melting point (about 1300°C) to $EuNbO_4$, isostructural with monoclinic fergusonite, and TiO_2, as rutile. The Sn, Nd, Pr, Ce, and La compounds did not undergo such transformations. (TTT)

20014 AQUEOUS CHEMISTRY OF ZIRCONIUM. PART II. ZIRCONYL CHLORIDE-DICARBOXYLIC ACIDS SYSTEMS. V. V. Subbanna and A. K. Bhattacharya (Univ. of Saugar, India). Indian J. Chem., 1: 149-52(Apr. 1963).

The behavior of oxalate, malonate, succinate, glutarate, adipate, maleate, malate, tartrate, and citrate ions when added to zirconyl chloride solution was investigated. Oxalic, malonic, malic, tartaric, and citric acids and their salts yielded precipitates with no definite composition. Addition of excess of the reagents caused the dissolution of the precipitate. Succinic, glutaric, adipic, and maleic acids gave no precipitate, whereas their salts gave bulky precipitates. Dialysis and electrometric results led to the conclusion that the precipitate is formed due to the coagulation caused by the ligands and dissolution is due to peptization of the coagulated mass. Solutions peptized by hydroxy acids gave no precipitate when an alkali was added to them and zirconium passes through the dialyzer on dialysis, which may be due to peptization accompanied by complex formation. No evidence was obtained to consider the precipitates as complex compounds. (auth)

20015 CERIUM VALENCE IN SYNTHETIC AND NATURAL CERIUM ALUMINATES AND SILICATES. I. COMPOUNDS OF THE PEROVSKITE GROUP. A. I. Leonov (Grebenshchikov Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 1, 8-13(Jan. 1963). (In Russian)

The valence of cerium in perovskite compounds was studied, and the solid solutions, $CeAlO_3-LaAlO_3$ and $CeAlO_3-SmAlO_3$, were synthesized. The influence of the gaseous medium and temperature on the stability of (x $CeAlO_3$, y $LnAlO_3$), where Ln is La and Sm, was analyzed. In synthetic ceralite mineral cerium appears in the trivalent state in a perovskite $CeAlO_3$. (R.V.J.)

20016 CONSTITUTION DIAGRAM OF $MgAl_2O_4-NdAlO_3$ SYSTEM. N. A. Toropov and N. A. Sirazhiddinov (Inst. of Chemistry of Silicates, Academy of Sciences, USSR). Izv. Akad. Nauk SSSR, Otd. Khim. Nauk, No. 2, 374-6(Feb. 1963). (In Russian)

Crystallographic and x-ray analyses were made of $MgAl_2O_4-NdAlO_3$. The system has simple eutectics without chemical or solid solutions. An eutectic point was found at 1835°C with a composition of 62 mole % $MgAl_2O_4$ and 38 mole % $NdAlO_3$. (R.V.J.)

20017 EVAPORATION OF HAFNIUM OXIDE. S. A. Shchukarev and G. A. Semenov. Izv. Vysshykh Uchebn. Zavedenii, Khim. i Khim. Tekhnol., 5: 845(1962).

The composition of vapors above HfO_2 in the 1900 to 2100°C range was studied with the use of a mass spectrometer. It was shown that the vapors, in contrast to ZrO_2 and ThO_2, contain almost no HfO_2 and that at the temperatures studied the concentration of gaseous Hf atoms above HfO_2 is less than 1% of the concentration of gaseous HfO molecules. (OTS)

20018 THE MOLECULAR AND CRYSTAL STRUCTURES OF π-CYCLOPENTADIENYL π-CYCLOHEPTATRIENYL VANADIUM. Gordon Engebretson and R. E. Rundle (Ames Lab., Ames, Iowa). J. Am. Chem. Soc., 85: 481(1963). (IS-586)

The previously reported sandwich structure of the $(C_5H_5)(C_7H_7)V$ complex is confirmed, and details of the structure are reported. The crystals are orthorhombic with space group Pnma and lattice constants a = 11.058 ± 0.014 Å, b = 10.845 ± 0.016 Å, c = 7.929 ± 0.007 Å. The V atom coördinates are x/a = 0.144, y/b = 0.25, z/c = 0.464 in 4c of Pnma, indicating mirror symmetry. The perpendicular distance from the V atoms to the C_7 ring is 1.50 Å, and the distance to the C_5 ring is 1.90 Å. The V-C distances are all equal, 2.24 ± 0.01 Å. The C-C distances are 1.403 Å in the C_7 ring and 1.424 Å in the C_5 ring. (D.L.C.)

20019 KINETICS OF HYDROLYSIS OF ACETALS IN PROTIUM AND DEUTERIUM OXIDES. Martin Kilpatrick (Argonne National Lab., Ill.). J. Am. Chem. Soc., 85: 1036-8(Apr. 20, 1963).

The acid-catalyzed hydrolysis of ethylene acetal (2-methyl-1,3-dioxolane) and dimethyl acetal (1,1-dimethoxyethane) was studied over the temperature range 0 to 40°C. The experimental results can be represented within the experimental accuracy by a two-parameter Arrhenius equation and the ratio of the velocity constants in deuterium oxide to protium oxide is dependent on the difference in the energies of activation. The ratio $k_{D_2O}^{DCl}/k_{H_2O}^{HCl}$ decreases with increasing temperature for both acetals and is in qualitative agreement with theoretical calculations. (auth)

20020 AN INVERSE CARBON ISOTOPE EFFECT ON THE IONIZATION OF TRIPHENYLMETHYL CHLORIDE. KINETIC ISOTOPE EFFECTS ON S_N1 AND S_N2 REACTIONS. A. J. Kresge (Illinois Inst. of Tech., Chicago), N. N. Lichtin, and K. N. Rao. J. Am. Chem. Soc., 85: 1210-11(Apr. 20, 1963). (TID-18192)

An isotope effect on an equilibrium closely related to S_N1 heterolysis, which supports a low rate ratio, is reported; the $C^{12}:C^{13}$ equilibrium constant ratio for the ionization of triphenylmethyl chloride in liquid sulfur dioxide at 0°C is 0.983. Analysis of the system suggested that carbon isotope effects on S_N1 reactions may in general be smaller than those on S_N2 reactions. The principal source of the inverse isotope effect of 1.7% on the ionization of triphenylmethyl chloride is the increased strength of carbon-phenyl bonds in the triphenyl carbonium ion. (P.C.H.)

20021 THE KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XI. TRITIUM EXCHANGE BETWEEN SECONDARY ALCOHOLS AND ACIDIC MEDIA.

V. Gold and R. S. Satchell (London Univ.). J. Chem. Soc., 1930-7(Mar. 1963).

The six β-hydrogen atoms of isopropyl alcohol undergo isotope exchange with a strongly acidic solvent (3 to 8M-perchloric acid) containing tritium. The exchange velocity at 100° is proportional to $h_0^{0.9}$ and is consistent with the view that the reaction involves dehydration to propene followed by re-addition of water. In cyclohexanol the corresponding reaction involves all eleven C–H bonds and is compatible with an analogous mechanism via cyclohexene. (auth)

20022 THE KINETICS OF HYDROGEN ISOTOPE EXCHANGE REACTIONS. PART XII. THE BEHAVIOUR OF PRIMARY ALCOHOLS IN ACIDIC MEDIA. V. Gold and R. S. Satchell (London Univ.). J. Chem. Soc., 1938-47(Mar. 1963).

Propyl alcohol rearranges to isopropyl alcohol in 8M perchloric acid at 100°. The equilibrium constant of the rearrangement is ≥100. When performed in a tritiated medium, the reaction yields a product containing tritium, the rate of tritium uptake being consistent with the occurrence of exchange after rearrangement. The unrearranged alcohol contains no significant amount of tritium. Comparisons of the rate of rearrangement with rates of related reactions support the view that the rearrangement involves an intramolecular hydride shift in the propyl cation and does not go through propene. Experiments with cyclohexylmethanol in tritiated acidic media likewise indicate that there is no exchange in the primary alcohol but that exchange occurs in either a rearranged alcohol or its decomposition product(s). (auth)

20023 ENTHALPY DATA FOR THE ZIRCONIUM–HYDROGEN SYSTEM. D. G. Westlake (Argonne National Lab., Ill.). J. Nucl. Mater., 7: 346-7(Dec. 1962). (ANL-FGF-363; UAC-6650). (In English)

The enthalpy data for the Zr–H system comes from pressure-composition-temperature and heat content measurements. Below the eutectoid temperature of 550°C, $P^{\frac{1}{2}}$ increases linearly with composition (C) until the terminal solubility of H in alpha Zr is reached. The pressure remains constant with increasing C over the entire alpha + delta-hydride composition range. The pressure increases again in the single phase delta range. Above 550°C, at the terminal solubility, beta Zr begins to form and pressure remains constant in the alpha + beta range. (P.C.H.)

20024 STRUCTURE OF NIOBIUM OXIDES. Nobuzo Terao (Union Carbide European Research Associates, Brussels). Japan. J. Appl. Phys., 2: 156-74(Mar. 1963). (In French)

The formation of the niobium oxides by heating thin films and the powder of Nb in various conditions was followed by electron and x-ray diffractions. Numerous forms of Nb oxide were identified: Nb-(O) (solid solution), NbO_x (tetragonal), Nb-O δ-form (hexagonal), γ-Nb_2O_5 (monoclinic), and α-Nb_2O_5 (monoclinic) were formed by heating in air at either atmospheric or reduced pressure; while, NbO_x (tetragonal), NbO (cubic), and NbO_2 (tetragonal) were formed only in air at reduced pressure. The transformation relations between the oxides are made clear. At first, the oxidation of Nb occurs through penetration of O atoms into the metallic lattice of Nb. Then the structures of the oxides transform successively by rearrangement of Nb and the O atoms. The transformation $\delta \rightarrow \gamma$ can take place through a relatively small change in the atomic distribution, while the transformation $\gamma \rightarrow \alpha$ occurs through a remarkable rearrangement of both kinds of atoms, passing two distinct intermediate stages. The δ-form may be an oxide inferior to NbO_2. The tetragonal form NbO_2 has a super lattice derived from the rutile structure. (auth)

20025 DETERMINATION OF THE COMPOSITIONS AND THE STABILITIES OF URANIUM(VI) OXALATO COMPLEXES BY ULTRAVIOLET SPECTROPHOTOMETRY. Hirondo Kurihara and Toru Nozaki. Nippon Kagaku Zasshi, 83: 1246-9(Dec. 1962).

The compositions and stability constants of U(VI) oxalato complexes in aqueous solutions were determined spectrophotometrically in the ultraviolet region by the continuous variation and the mole ratio method. The absorption curves of U oxalato complex had inflexions at 240 and 250 mμ and the absorbance increased with the pH value, approaching that of the solution of pH 5. On the contrary, the absorption curve of U perchlorate changed its shape as the pH increased, presumably because of the formation of polymers due to the hydrolysis of uranyl ion. In acid solutions, 4 kinds of complex were found with $U^{6+}:C_2O_4^{2-}$ ratios of 1:1, 1:2, 1:3, and 1:4, but when the pH was above 4, only the 1:4 complex was stable. Stability constants were calculated from the concentrations of free U ion, complexes, and free oxalate ion, which were determined graphically from the curves of absorbance vs mole ratio. The apparent stability constants of the 4 complexes were $10^{7.3}$, $10^{6.0}$, $10^{5.1}$, and $10^{4.5}$ at ionic strength 0.10 and 28°C. The molar extinction coefficients were 2.8, 3.5, 4.1, and 4.5×10^3 l/mole cm at 240 mμ and 2.3, 3.3, 3.8, and 4.0×10^3 l/mole cm at 250 mμ. Use of the 1:4 complex for the photometric determination of U^{6+} was studied. The intensity of the absorption at 240 mμ remained constant for more than 24 hr at pH 5.0 and Beer's law held within the concentration range of 1 to 30 ppm. Ions like Cu^{2+}, Fe^{3+}, V^{5+}, and Mo^{6+} interfered with the determination of U^{6+}, but Na^+, Cl^-, and SO_4^{2-} did not. (H.H.D.)

20026 THE ISOTOPE EFFECT IN THE SPECTRUM OF DYSPROSIUM. A. R. Striganov, A. F. Golovin, and M. P. Gerasimova. Opt. Spectry. (USSR) (English Transl.), 14: 3-5(Jan. 1963).

The isotopic shift was measured between the components of even isotopes of dysprosium for 30 lines. In contrast to previous investigations, enriched isotopes were used. Nonuniformity was discovered in the shift; in the case of two intervals, this is satisfactorily explained by variations in the deformation parameter. From the relative isotopic shift, new values were calculated for the deformation parameters and the internal quadrupole moments of Dy^{160} and Dy^{158}. (auth)

20027 DETERMINATION OF THE OSCILLATOR STRENGTHS OF THE ABSORPTION BANDS OF GADOLINIUM IONS. G. V. Ostrovskaya and Yu. I. Ostrovskii. Opt. Spectry. (USSR) (English Transl.), 14: 83-4(Jan. 1963).

The oscillator strengths of the absorption bands of Gd^{3+} were determined in an aqueous solution of $GdCl_3$ and in a phosphate glass with added Gd_2O_3. The measurements were carried out by the absorption method. (C.E.S.)

20028 THE ABSORPTION, LUMINESCENCE, AND LASER ACTION OF NEODYMIUM IN SrF_2 CRYSTALS. Ya. E. Kariss and P. P. Feofilov. Opt. Spectry. (USSR) (English Transl.), 14: 89-90(Jan. 1963).

The absorption and luminescence spectra and the laser action of Nd^{3+} in strontium fluoride single crystals were observed. The absorption spectra were measured at 300°K. The wavelengths of the most intense lines in the SrF_2:Nd luminescence spectra were observed at 77°K. The laser spectrum contains only one line that coincides exactly with the luminescence line at 1.044 μ. (C.E.S.)

20029 ION EXCHANGE IN POROUS CRYSTALS. PART I. SELF- AND EXCHANGE-DIFFUSION OF IONS IN CHABAZITES. R. M. Barrer, R. F. Bartholomew, and L. V. C. Rees (Imperial Coll. of Science and Tech., London). Phys. Chem. Solids, 24: 51-62(Jan. 1963). (In English)

Self-diffusion and exchange diffusion kinetics were studied for a number of ions in hydrated chabazites, and the corresponding diffusion coefficients were determined. Values of the self-diffusion coefficients follow the Arrhenius equation [$D^* = D_0 \exp(E/RT)$]. The energy barriers, E, associated with each unit self-diffusion process are about 7 kcal for all the ions Na^+, K^+, Rb^+, and Cs^+; for Ca^{2+} and Sr^{2+} the barriers are approximately twice this magnitude, but for Ba^{2+} they are 8.7$_5$ kcal. The results are considered in terms of the structure of the crystals and of the possibility that the periodic variation in the intracrystalline electrostatic field determines E. Entropies of activation, and also comparison with other rate processes in chabazite (self-diffusion of water, electrical conductivity, and dielectric relaxation) suggest that ions and water molecules may participate together in each unit diffusion process. In mixed (Ca,Sr)-chabazites the self-diffusion coefficients D^* of Ca^{2+} and of Sr^{2+} each decrease strongly with the exchangeable cation fraction of Ca^{2+} and of Sr^{2+}, respectively. Values obtained for exchange diffusion coefficients of Ca–Sr, Ca–Ba, and Sr–Ba pairs are integral values over a range of cation fractions. (auth)

20030 ION EXCHANGE IN POROUS CRYSTALS. PART II. THE RELATIONSHIP BETWEEN SELF- AND EXCHANGE-DIFFUSION COEFFICIENTS. R. M. Barrer, R. F. Bartholomew, and L. V. C. Rees (Imperial Coll. of Science and Tech., London). Phys. Chem. Solids, 24: 309-17(Feb. 1963). (In English)

It has been shown that, using chabazite as exchanger, no previous theoretical treatment allows one to calculate integral (and therefore differential) inter-diffusion coefficients, D_{AB}, from the self-diffusion coefficients, D_A^* and D_B^*, for the ion-pairs $Ca^{2+} \rightleftharpoons Sr^{2+}$, $Ca^{2+} \rightleftharpoons Ba^{2+}$, and $Sr^{2+} \rightleftharpoons Ba^{2+}$. In part the failure of the previous treatments arises from a strong dependence of the self-diffusion coefficients upon the cationic composition of the chabazites, as shown for Sr^{2+} and Ca^{2+}. However, correction for this concentration dependence still left a substantial discrepancy between theoretical and experimental values of D_{AB}. A second important factor is that the previously developed expression relating the differential inter-diffusion coefficient D_{AB} and D_A^* and D_B^*, $D_{AB} = D_A^* D_B^* (C_A Z_A^2 + C_B Z_B^2)/D_A^* C_A Z_A^2 + D_B^* C_B Z_B^2$, is oversimplified. The correct relationship is derived, and a special case of this relationship was used to recalculate the integral inter-diffusion coefficients for the $Sr^{2+} \rightleftharpoons Ca^{2+}$ exchange. Although this improved the correspondence between measured and calculated inter-diffusion coefficients, the discrepancy remained considerable. Some possible reasons for this were discussed. (auth)

20031 NUCLEAR MAGNETIC RESONANCE IN PLATINUM. L. E. Drain (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phys. Chem. Solids, 24: 379-82(Mar. 1963). (In English)

Measurements of the nuclear magnetic resonance of Pt^{195} in platinum metal were made from 24 to 299°K in fields of 1.75 and 9.50 kilogauss. The dependence of line width on field was attributed to line broadening by field inhomogeneities in the powdered sample due to paramagnetism. After allowance for this, a value of the spin-spin relaxation time of 1.1 ± 0.2 msec was deduced. The product of the spin-lattice relaxation time and the absolute temperature was substantially constant and equal to 35 ± 1 msec-deg. The results are in agreement with those obtained by pulse methods. The Knight shift was independent of field but varied from –4.006 ± 0.005% at 24°K to –3.525 ± 0.003% at 299°K relative to chloroplatinic acid. Shifts in some other platinum compounds are also given. (auth)

20032 A MAGNETIC AND NEUTRON DIFFRACTION STUDY OF THE Cr_2O_3–Fe_2O_3 SYSTEM. D. E. Cox, W. J. Takei, and G. Shirane (Westinghouse Electric Corp., Pittsburgh). Phys. Chem. Solids, 24: 405-23(Mar. 1963). (In English)

The magnetic structures of solid solutions $(1-x)Cr_2O_3$–xFe_2O_3 were determined by neutron diffraction and magnetic measurements. The different antiferromagnetic structures of Cr_2O_3 and Fe_2O_3 are revealed to be connected through cone spiral structures in such a way that continuity is preserved. For the purpose of describing the latter, the fundamental Cr_2O_3 type of magnetic structure is divided into two sublattices, within each of which the spins are coupled ferromagnetically, with antiferromagnetic coupling between the sublattices. The addition of Fe_2O_3 creates a cone spiral within each sublattice, both the cone axis and the spiral wave vector lying along the hexagonal c-axis. The cone angle increases with increasing Fe_2O_3 content up to x = 0.15. In the region $0.2 \leq x \leq 0.35$, the cone axis lies perpendicular to the c-axis, although the spiral wave vector remains parallel to the latter, resulting in a cycloidal arrangement. The spin components along the cone axis now have the fundamental Fe_2O_3 type of magnetic structure. As the Fe_2O_3 content increases, the cone angle decreases, until finally when this becomes zero, the Fe_2O_3 type of magnetic structure is attained. (auth)

20033 STRUCTURE AND MAGNETIC PROPERTIES OF URANIUM OXYSULFIDE (UOS). R. Ballestracci, E. F. Bertaut, and R. Pauthenet (Laboratoire d'Electrostatique et de Physique du Métal, Grenoble, France and Centre d'Études Nucléaires, Grenoble, France). Phys. Chem. Solids, 24: 487-91(Mar. 1963). (In French)

UOS is tetragonal and antiferromagnetic with a Néel temperature $T_N = 55$°K and a paramagnetic Curie temperature $\Theta_p = -51$°K. In the antiferromagnetic region, there is a strong uniaxial anisotropy. Every uranium atom has a moment of about 2 μ_B, directed along the c-axis. The interactions U–O–U are strongly negative. The succession of moments along c is + + – –. The magnetic unit cell is twice the chemical one along c. In the paramagnetic region, the inverse of the magnetic susceptibility vs temperature shows two linear portions with corresponding Curie constants $C_1 = 0,9$ (at low temperatures) and $C_2 = 1,2$ (at T > 450°K). (auth)

20034 GASEOUS SELF-DIFFUSION IN A TEMPERATURE GRADIENT. R. P. Wendt, J. N. Mundy, Stanley Weissman, and E. A. Mason (Univ. of Maryland, College Park). Phys. Fluids, 6: 572-8(Apr. 1963).

Deviations from the quasistationary state in diffusion were studied experimentally by measuring self-diffusion of gases, both isothermally and in a temperature gradient. Thermal diffusion is negligible in the cases considered. The nonisothermal measurements also serve as a check on the fundamental diffusion equation, which was not previously tested except under isothermal conditions. The technique is convenient for obtaining diffusion coefficients over wide temperature ranges without the necessity of having all parts of the apparatus at an extreme temperature. Self-diffusion coefficients for CO_2 and Kr were obtained over the range of about 230 to 470°K by this method. Although

the corrections for nonattainment of the quasistationary state are not small in the apparatuses used, the values for CO_2 are in good agreement with those from other sources and the values for Kr are in fair agreement with others, provided the temperature gradients were not too large. (auth)

20035 STOCHASTIC PROCESS OF KEILSON AND STORER. Abner Shimony (Boston Univ.). Phys. Fluids, 6: 590-1(Apr. 1963).

The stochastic process associated with the linear Boltzmann equation governing the probability density of the particle velocity in an idealization of the Brownian movement was identified explicitly, and a fundamental solution of this equation was derived by a considerably simpler method. (C.E.S.)

20036 NUCLEAR CROSS-RELAXATION INDUCED BY SPECIMEN ROTATION. E. R. Andrew, A. Bradbury, R. G. Eades, and V. T. Wynn (University Coll., North Wales). Phys. Letters, 4: 99-100(Mar. 15, 1963). (In English)

The spin lattice relaxation times T for the P^{31} nuclei of the PCl_4^+ and PCl_6^- ions in a phosphorus pentachloride crystal are determined by a direct-recovery method. When rotated rapidly about an axis inclined at an angle 54°44′ to the applied magnetic field of 5 k gauss, the values of T are ~6 and 0.6 sec for the tetrachloride and hexachloride ions, respectively. When the rate of rotation coincides with the frequency interval between the two resonance lines, the two relaxation times become equal, both become relaxing with the shorter time 0.6 sec. (C.E.S.)

20037 PARAMAGNETIC RESONANCE OF Gd^{3+} IN SrF_2 AND BaF_2. J. Sierro (Université, Geneva). Phys. Letters, 4: 178-80(Apr. 1, 1963). (In English)

Electron paramagnetic resonance spectra of Gd^{3+} were observed in single crystals of strontium and barium fluoride. The effects of thermal treatment and hydrolysis at high temperatures on the electron paramagnetic resonance spectra were studied. Two synthetic single crystals from semi-elements doped in the melt with 0.02% GdF_3 by weight were used. The orientation of the samples was achieved by cleavage along the [111] directions and the static magnetic field was rotated in a (110) plane. (C.E.S.)

20038 STRUCTURAL INFORMATION FROM MAGNETIC MEASUREMENTS ON LANTHANUM COBALT NITRATE. M. J. M. Leask and W. P. Wolf (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 81: 252-9(Feb. 1, 1963).

Measurements of the susceptibility parallel and perpendicular to the principal axis were made on single crystals of $La_2Co_3(NO_3)_{12} \cdot 24H_2O$ at temperatures between 1.5 and 20.4°K. The results were fitted to laws. The Curie constants $C_{||}$ and $C_{\perp}$ combined with paramagnetic resonance g values were used to find a value for the ratio of the two types of inequivalent Co^{2+} ions, X : Y = 1.94 ± 0.15, in agreement with recent x-ray measurements that give 2 : 1. The temperature-independent terms $\gamma_{||}$ and $\gamma_{\perp}$ are discussed in terms of the theory of Abragam and Pryce and a number of simplifying assumptions, and confirm general estimates of the low-lying energy levels. The interaction terms $(\theta_1)_{||}$ and $(\theta_1)_{\perp}$ are shown to be mainly due to exchange coupling, the magnitude of which lends support to one of two alternative crystal structures that were proposed. (auth)

20039 THE ROTATIONAL ANALYSIS OF THE (2,1), (0,0) AND (0,1) BANDS OF THE $^3\Pi - ^3\Sigma$-SYSTEM OF OD^+. S. O'Connor (University Coll., Dublin). Proc. Roy. Irish Acad., Sect. A, 62: 73-92(Dec. 1962).

The emission spectrum of OD^+, using microwave excitation, was photographed in the near ultraviolet. Rotational analysis of the (2,1), (0,0), and (0,1) bands of the $^3\Pi - ^3\Sigma$-system are given. Revised values for some of the molecular constants of the isotopic molecule OH^+ are presented. (auth)

20040 ISOTOPE EFFECTS IN THE TRANSFER OF VIBRATIONAL ENERGY IN GASEOUS COLLISIONS. R. C. Milward and A. R. Ubbelohde (Imperial Coll., London). Proc. Roy. Soc. (London), Ser. A, 272: 481-9(Apr. 9, 1963).

Previously available studies of isotope effects in catalysts for the transfer of vibrational energy were extended by comparing catalytic effects of NH_3 and ND_3. For each of the three vibrators, ethylene, methyl chloride, and cyclopropane, vibration-vibration transfer appears to be only of subsidiary importance in the overall catalysis observed. With these vibrators, good agreement is found between observed relative efficiencies of H_2O and D_2O, and H_3N and D_3N as energy transfer catalysts. With ethylene, relative efficiencies of H_3N and D_3N can probably be attributed to mass differences. But even after allowing for mass differences of the isotopic molecules, collisions with some of the other vibrators show residual predominance of the hydrogen over the deuterium derivative as catalyst. This can possibly be attributed to effects of rotation during a collision, on the steric factor. To advance our knowledge about energy transfer further, more accurate information is needed about the origin and magnitude of intermolecular repulsions. (auth)

20041 ISOTOPE EFFECTS ON THE DISTILLATION OF AQUEOUS SOLUTIONS OF TRITIUM-LABELED FORMALDEHYDE. H. Simon and G. Heubach (Technische Hochschule, Munich). Z. Naturforsch., 18b: 160-1(Feb. 1963). (In German)

Curves are presented showing the radioactivity pattern in the fractional distillation of aqueous solutions of tritium-labeled formaldehyde under various conditions. The fractionation of the tritium-labeled formaldehyde was much stronger than tritium-labeled water under the same conditions. It was concluded that this is the result of an equilibrium isotope effect. (M.C.G.)

20042 A STRUCTURE OF THE Th_3P_4 TYPE AS AN ARRANGEMENT OF POLYHEDRONS. P. I. Kripyakevich (L'vov State Univ., USSR). Soviet Phys.-Cryst. (English Transl.), 7: 556-8(Mar.-Apr. 1963).

It is shown that a structure of the Th_3P_4 type can be represented as an arrangement of polyhedrons such as $[ThP_8]$ or $[PTh_6]$. (auth)

20043 AN X-RAY INVESTIGATION OF STRONTIUM GERMANATE $SrGeO_3$. W. Hilmer (Inst. of Inorganic Chemistry, German Academy of Sciences, Berlin). Soviet Phys.-Cryst. (English Transl.), 7: 573-6(Mar.-Apr. 1963).

Patterson methods were used to plot the electron density projection of $SrGeO_3$. The structure is made up of alternating layers of $[Ge_3O_9]^{6-}$ rings and layers of Sr atoms. (auth)

20044 NITROGEN ISOTOPE EXCHANGE BETWEEN LIQUID N_2O_3 AND NO AT LOW TEMPERATURE AND ELEVATED PRESSURE. E. U. Monse, Lois Nash Kauder, and W. Spindel (Rutgers Univ., Neward, N. J.). Z. Naturforsch., 18a: 235-41(Feb. 1963). (In English)

The single stage separation factor, α, for nitrogen isotope exchange between liquid $N_2O_3 - N_2O_4$ mixtures and their vapor was measured at temperatures ranging from −76°C to room temperature and pressures between 1 atm. At −76°C and 1 atm., $\alpha = 1.061 \pm 0.003$; at −23°C and 1 atm., $\alpha = 1.034 \pm 0.002$; at +23°C and 2.1 atm., $\alpha = 1.017 \pm 0.002$; and at +23°C and 7.4 atm., $\alpha = 1.030 \pm 0.002$. The results

were compared with values, calculated from spectroscopic data for N_2O_3, N_2O_4, NO, and NO_2. The value of $\alpha = 1.030$ found at room temperature and 7.4 atm. pressure enhances the usefulness of the N_2O_3–NO-system for separating the nitrogen isotopes, since it eliminates the need of refrigeration. (auth)

20045 ISOTOPIC THERMAL DIFFUSION FACTORS FOR HELIUM AND NEON AT LOW TEMPERATURES. W. W. Watson, A. J. Howard, N. E. Miller, and R. M. Shiffrin (Yale Univ., New Haven). Z. Naturforsch., 18a: 242-5(Feb. 1963). (In English)

With an all-metal "swing separator" having unique features, thermal diffusion factors α_T for He^3/He^4 and Ne^{20}/Ne^{22} were measured with improved accuracy down to average gas temperatures T = 136°K. For helium α_T was 0.0696 ± 0.0010 at 136°K, dropping gradually to 0.0651 ± 0.0010 at 313°K. These data, plus measurements by Van Der Valk and De Vries at somewhat higher temperatures, agreed best with values predicted by an exp-six intermolecular potential with $\epsilon/k = 9.16$ and $\alpha = 12.7$. These helium measurements are being extended down to t = 4°K for the lower temperature, to detect if possible quantum corrections to the intermolecular potential. For neon α_T increased from 0.0166 ± 0.0010 at 136°K to 0.0233 ± 0.0020 at 310°K, considerably higher than previously reported values. These thermal diffusion factors for neon were in good agreement with values calculated from an exp-six potential with $\epsilon/k = 46.0 \pm 0.6$ and $\alpha = 13$. (auth)

20046 UV ABSORPTION SPECTRA OF CRYSTALLINE SALTS OF THE RARE EARTHS. I. EUROPIUM SALTS. K. H. Hellwege, S. Huefner, and A. Poecker (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 172: 453-9 (1963). (In German)

The ultraviolet absorption spectra of trivalent europium were investigated up to a wavelength of 2500 Å in salts of different symmetries. For a series of different energy levels, the total three-impulse quantum number was determined. By comparison with calculations in the Russell-Saunders approximation some line-group transitions from the ground level $^7F_0$ to excited Russel-Saunders levels were assigned. (tr-auth)

20047 UV ABSORPTION SPECTRA OF CRYSTALLINE SALTS OF RARE EARTHS. II. GADOLINIUM CHLORIDE. K. H. Hellwege, S. Huefner, and H. Schmidt (Technische Hochschule, Darmstadt, Ger.). Z. Physik, 172: 460-4 (1963). (In German)

The absorption spectra of $GdCl_3 \cdot 6H_2O$ and $Y(Gd)Cl_3 \cdot 6H_2O$ were plotted in the region between 32000 and 41000 cm^{-1}. All levels of the multiplets ^6P, ^6I, and ^6D were determined. (tr-auth)

20048 THE NUCLEAR MAGNETIC RESONANCE AND THE ELECTRON PARAMAGNETIC RESONANCE OF LiF DOPED WITH MnF_2. Te-tse Chang. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 69p.

An investigation was performed of the shape of NMR (nuclear magnetic resonance) and EPR (electron paramagnetic resonance) lines in crystalline structure of cubic symmetry. Powdered lithium fluoride samples doped with paramagnetic divalent manganese ions of various concentration were chosen. The NMR lines of Li^7 and F^{19} were observed at temperatures of 77, 4, and 1.5°K. The width of the lines was measured. For samples with more than one per cent added manganese, a slight increase of the line width for Li^7 was observed toward low temperatures. For a sample with a 10 per cent manganese concentration, a decrease of the line width of F^{19} was found at low temperatures. For the other samples, essentially no change in the line width was detected. The EPR spectrum of Mn^{2+} was investigated at room temperature. Well resolved hyperfine lines for all the samples were observed. The observed NMR line widths are in contradiction to the present theories which derived the second moments on the basis of a pure dipole-dipole interaction between the nuclear species measured and the various nuclear and electronic spins in a more or less static crystalline structure. The experimental results on the NMR line widths of F in the manganese-doped lithium fluoride indicated the presence of a narrowing mechanism for the fluorine. Whether a possible antiferromagnetism of the manganese moments at low temperatures together with a possible mobility of lattice vacancies can account for the observed effects is not yet understood. (Dissertation Abstr. XXIII, No. 8)

20049 DYNAMICAL THEORY OF ISOTOPICALLY DISORDERED CRYSTALS. Charles Chin-tse Chen. Thesis, College Park, Md., Univ. of Maryland, 1962. 93p.

Some of the effects of randomly distributed isotopic impurities on the vibrational properties of crystals have been studied. A method of evaluating the trace of the inverse of the dynamical matrix of disordered crystals is presented and the result is applied to the evaluation of additive functions of normal mode frequencies. The case of a small concentration of one kind of isotope is treated in detail. By the use of Laplace transform methods, the displacement correlation function is evaluated. With the aid of this result the complex frequency shift of the normal mode frequencies in disordered crystals is computed. The method is then applied to the calculation of optical absorption in the infrared by mixed alkali-halide crystals or by isotopically disordered alkali-halide crystals. Finally, the diffuse scattering of x rays by a disordered crystal in its quantum-mechanical ground state is considered. The evaluation of the ensemble average of exp ($i \underline{K} \cdot \underline{u}(\underline{l})$) ($\underline{K}$ is some constant vector and $\underline{u}(\underline{l})$ the displacement vector of an atom from its equilibrium position) which appears directly in the theory of diffuse x-ray scattering is reduced, by a proper choice of perturbed Hamiltonian, to the problem of computing the change in the zero-point energy of a system, and this can be evaluated by the method of linked cluster expansions. (Dissertation Abstr. XXIII, No. 8)

20050 THE INTERACTIONS OF RARE-GASES AND ISOTOPIC PAIRS WITH GRAPHITIC CARBON. John Robert Sams, Jr. Thesis, Seattle, Univ. of Washington, 1962. 185p.

Data previously obtained in this laboratory for the interactions of gas atoms with surfaces at very low coverages indicated the desirability of using a well-defined, low-surface-area, homogeneous solid as adsorbent. The high-precision adsorption apparatus, which had been constructed for this purpose, was employed in the present study to obtain data for the interactions of several gases with the highly graphitized carbon black P33 (2700). Neon, argon, krypton, and xenon have been investigated in the second-order interaction region. The data have been analyzed in terms of a virial-coefficients treatment analogous to that used in imperfect gas theory, to yield gas-surface interaction energies and estimates of the adsorbent surface area. Four different models for the interaction potential and five formulas for obtaining apparent areas from the data have been examined. Third-order interaction data for argon with P33 have been analyzed through a two-dimensional gas treatment. Relations between this treatment and the gas-surface virial expansion are presented, and the two treat-

ments are shown to be consistent. An independent estimate of the surface area is obtained, and agrees well with values found from second-order data. Data for the argon-P33 system have been obtained for surface coverages up to about 1.5 layers. Heats and entropies of adsorption as a function of coverage obtained from these data are presented and discussed. BET estimates of the area are discussed in light of the independent values mentioned above. The interactions of two isotopic pairs (H_2-D_2 and CH_4-CD_4) in the second-order region have been studied. In the case of the hydrogen experiments, D_2 is found to give the anticipated higher interaction energy. The methane results are surprising in that CH_4 interacts more strongly with the surface than does CD_4. This inverse effect cannot be explained on the basis of the mass effect on the vibrational levels, and for this reason no quantum mechanical correction has been included in the configuration integral. It is suggested that the second effect which is apparently present may be a rotational one, or may be due to a change in polarizability of the molecules in deuterium substitution. (Dissertation Abstr., XXIII, No. 8)

20051 SOME ELECTROCHEMICAL STUDIES OF INORGANIC SYSTEMS. Sheldon Hersh Cohen. Thesis, Lawrence, Kansas, Univ. of Kansas, 1962. 139p.

Voltammetry at a rotating platinum electrode was used to study the complexes formed between silver (I) and oxalate ions. From half-wave potential measurements at different oxalate concentrations, the formula of the complex was found to be $AgC_2O_4^-$. With the use of an extrapolation technique a pK_{inst} of 2.41 was obtained for the complex. The complexes formed between praseodymium (III) and perchlorate, chloride, and bromide ions in ethanol were investigated using both polarographic and spectrophotometric methods. Although no quantitative data could be obtained, it was found that a number of different complexes (or ion-associates) exist simultaneously in each of the three systems studied. From the polarographic data it appeared that the complexing strength was in the order $Br^- > Cl^- > ClO_4^-$. The reduction of the aqueous hydrogen ion in the presence of various metal ions was investigated. Metal ions that do not undergo hydrolysis (Li^+ and Mg^{++}) had no effect on the reduction of hydrogen ion. The reduction of hydrogen ion in the presence of varying concentrations of praseodymium(III) perchlorate gave a series of parallel lines for the plots of diffusion current versus hydrogen ion concentration in the bulk of the solution. This observation was explained with the use of a mechanism that assumed the formation of hydroxo-complexes. The hydrogen ion reduction in the presence of cerium(III) was found to be dependent on the age of the solution. This fact was explained in terms of hydrolysis of the cerium(III). Fifteen suggestions for future research on the use of electrochemical methods in the study of inorganic systems were made. (A.G.W.)

Organic Chemistry

20052 (IDO-16851) ORGANIC COOLANT DEGRADATION STUDIES. D. G. Kuper (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 25, 1963. Contract AT(10-1)-205. 12p.

The rates of thermolytic decomposition of purified biphenyl, o-terphenyl, and m-terphenyl were measured at 750, 775, 800, and 825°F. The liquid phases were analyzed and the data interpreted by first-order kinetics. Reaction rate constants, energies of activation, and entropies of activation were calculated for each material tested. The results show that o-terphenyl degrades about five times faster than biphenyl or m-terphenyl. In the breakdown, it seems likely that a complex of high entropy is formed, which subsequently reacts or decomposes to give the observed breakdown products. A limited study was made on the combined effects of temperature and gamma radiation. The results show an increase of the radiolytic decomposition with temperature. There are insufficient data to determine the effects of temperature on the mechanism of radiolysis. (auth)

Radiation Chemistry and Radiochemistry

Refer also to abstracts 19725 and 19801.

20053 (AFCRL-62-626) THE TRIPLET STATE. Final Technical Report. George Porter (Sheffield, England, Univ.). Mar. 30, 1962. Contract AF61(052)-32. 20p. (AD-281776)

The first order decay of triplet states of naphthalene, anthracene, phenanthrene and their halogenated derivatives was studied in cyclohexane and viscous paraffin solutions. The decay results partly from a bimolecular quenching process and partly from a true first order radiation-less conversion to the ground state. The rate of the quenching process was a function of the solvent and, in anthracene derivatives, of the extent to which the solutions were irradiated. The rates of radiation-less conversion could only be measured when they exceeded the rates of quenching processes. Bromination of anthracene was 10 times more effective in enhancing conversion than chlorination at the same position and halogenation at the 9, 10 positions had four times the effect of halogenation at other positions. (auth)

20054 (ASD-TDR-63-65) THE GAS PHASE RADIOLYSIS OF 2-BUTYNE. L. A. Harrah, R. E. Rondeau, S. Zakanycz, D. Hale, and D. Dunbar (Aeronautical Systems Div., Wright-Patterson AFB, Ohio). Jan. 4, 1963. 11p.

Pyrex ampoules of gaseous 2-butyne (dimethylacetylene) were exposed to Co^{60} gamma rays, and the 100-ev yields of the lower molecular weight products are given. The radioinduced products were studied as a function of sample pressure and total dose. The products, which include hydrogen, methane, acetylene, propene, propyne, cis- and trans-2-butene, butane, 1,2-butadiene, and vinylacetylene, are explained on the basis of ion-molecule and free radical reactions. Some mechanisms of product formation, which are consistent with product distribution and magnitude of the yields, are discussed. (auth)

20055 (CRRP-1133) ABSORPTION CROSS SECTION OF FISSION PRODUCTS SEPARATED FROM SLUG 76-11 OF NRX ROD 76. A. Okazaki, R. G. Hart, and W. J. Henderson (Atomic Energy of Canada Ltd., Chalk River, Ont.). Jan. 1963. Includes Appendices: I. PLUTONIUM AND URANIUM ANALYSES ON ROD 76 SLUGS. M. Lounsbury. II. ISOTOPIC CONTENTS AND CROSS SECTIONS AS A FUNCTION OF IRRADIATION. S. A. Kushneriuk. III. MASS LOSS IN THE EXTRACTION OF FISSION PRODUCTS FROM IRRADIATED U METAL. W. H. Walker. IV. PSEUDO-FISSION PRODUCT YIELDS AND CROSS SECTIONS FOR REMANENT FISSION PRODUCTS. W. H. Walker. 48p. (AECL-1698)

The neutron absorption cross section of the fission

products separated from Slug 76-11 of NRX rod 76 was measured by the swing method in the PTR reactor. This piece of natural uranium metal had been irradiated to an integrated neutron flux of 1.67 n/kb. The measurements were made in two neutron spectra. The volatile fission products are known to have been lost in the chemical separation. The cross section of the non-volatile fission products was found to be $\sigma = (33.8 \pm 3.0) + (290 \pm 88)\, r\sqrt{T/T_0}$ barns/fission. It should be noted that there is considerable uncertainty in what fission products have been lost in the chemical separation. The effective cross section for all the fission products was determined as $\sigma = (40 \pm 3) + (330 \pm 88)\, r\sqrt{T/T_0}$ compared to the calculated cross section of $\sigma = 48 + 216\, r\sqrt{T/T_0}$. Isotopic contents and cross sections as a function of irradiation are included as are fission product cross sections. (auth)

20056 (DCAS-TDR-62-140) ISOTOPE EFFECTS AND THE MECHANISM OF ATOM PRODUCTION IN IRRADIATED ICE AT 4.2°K. Seymour Siegel (Aerospace Corp., El Segundo, Calif.); John M. Flournoy, and Henry Judeikis (Aerojet-General Corp., Azusa, Calif.). June 26, 1962. Contract AF04(695)-69. 20p. (AD-282727; TDR-69(2240-51)TN-1)

The relative intensities of the electron spin resonance (ESR) spectra of H and D atoms were determined for mixtures of H_2O and D_2O which were irradiated and observed at 4.2°K. A careful analysis of the results indicates that the yield of atoms per unit irradiation dosage exhibits no isotope effect, except for the system containing trace amounts of H_2O in D_2O. The presence of a large isotope effect for a system of D_2O containing approximately 0.1% H_2O is discussed in terms of energy transfer in the solid state. (auth)

20057 (TID-18500) THE MECHANISMS OF SOME RADIATION INDUCED GAS REACTIONS AND THE CHEMICAL REACTIONS OF ELECTRONS. Annual Report, June 1, 1962 to May 31, 1963. Benjamin P. Burtt (Syracuse Univ., N. Y.). Mar. 30, 1963. Contract AT(30-1)-1131. 18p.

The mass spectrometer was used to obtain ionization efficiency curves for negative ions formed in N_2O. Only O^- and NO^- were formed by 2 to 4-ev electrons; NO_2^- and N_2O^- were found in addition at energies of 25 to 75 ev. Pressure dependence studies of the ions showed the following kinetic orders: $O^- = 1$ at low pressure and over the entire energy range. At higher electron energies, the order is 1 at low pressure, but increases to about 2 at higher pressure; $NO^- = 2$ at low energy, and 4 at higher energies: $NO_2^- = 4$, and $N_2O^- = 6$. When the concentration of electrons was raised, N_2O^+ and O^- showed first order dependence upon electron concentration. However, the intensity of NO^-, NO_2^-, and N_2O^- varied as the second power of the electron concentration. Ion yields for the production of hydrogen from the radiation of benzene, cyclohexane, and n-hexane in the gas phase were measured at several pressures and as a function of applied electric field. In benzene, the yield rose rapidly when the electrons were accelerated to energies to the order of 5 to 8 ev by the electric field. Cyclohexane showed a similar effect, but n-hexane showed more normal behavior. (P.C.H.)

20058 THE EFFECTIVE CROSS SECTION OF THE H ATOM IN BENZENE AND IRRADIATION PRODUCTS. Bernhard Broecker (Universität, Kiel). Atomkernenergie, 8: 81-9(Mar. 1963). (In German)

The cross sections of the (n,p) scattering in benzene and in a mixture of benzene and its irradiation products were measured in the region between 0.03 and 0.3 ev at the neutron crystal spectrometer at the FRG. The resolving time of the electronic apparatus and the second-order contamination of the monochromatic beam were measured and corrections were made. For control of the results the cross section of (n,p) scattering in water was measured, giving exactly the same values as in previous measurements. A difference of the cross section between benzene and the mixture was not found, as would be expected by the theory, because there are the same binding forces in benzene and its irradiation products. (auth)

20059 RADIOCHEMICAL METHOD FOR THE SEPARATION OF CESIUM AND FRANCIUM. A. V. Bellido Postigo. Bol. Inform. Junta Control Energ. At. (Peru), 7: 4p.(1963). (In Spanish)

A step-by-step radiochemical method is given for the separation of Cs and Fr from proton-irradiated thorium targets. The two elements are precipitated as the silicotungstate. There is no separation of the Cs and Fr from each other by the procedure given. (J.S.R.)

20060 RADIATION-INDUCED ADDITION OF ACETALDEHYDE TO ETHYLENE. Kozo Hirota, Shinji Iizuka, Hiroshi Ochi, and Motoyoshi Hatada (Japanese Assn. for Radiation Research on Polymers, Osaka and Osaka Univ.). Bull. Chem. Soc. Japan, 36: 115-20(Jan. 1963).

It was found that radiation-induced addition of acetaldehyde to ethylene occurs at room temperature with a relatively high $G(-C_2H_4)$, e.g., 4000 at the initial pressure of 50 kg/cm^2 of ethylene, and that the production of 1:2 telomer is more favorable than that of 1:1 telomer at higher pressure of ethylene. In order to obtain higher G values of 1:1 telomer, it is shown to be unnecessary to make the initial pressure of ethylene higher than 10 kg/cm^2, and also to elevate the irradiation temperature much higher than room temperature. It was confirmed that a major part of the telomerization proceeds by a chain mechanism, which accompanies a chain-transfer process simultaneously, acetyl radical playing a role of the chain-carrying radical as well as role of initiator. Moreover it is pointed out that the acetyl radical reacts with ethylene more easily than decomposes, though the decomposition is assumed to occur dominantly in the photochemical and thermal decomposition of acetaldehyde alone. (auth)

20061 PRODUCTS OF THE RADIOLYSIS OF WATER CONTAINING BENZENE AND NITRIC ACID. Ken'ichi Sugimoto, Wataru Ando, and Shigeru Oae (Osaka Radiation Center). Bull. Chem. Soc. Japan, 36: 124-6(Jan. 1963). (In English)

A study was made on the radioinduced formation of p-nitrophenol in water–benzene–nitric acid solutions. The G-value for p-nitrophenol decreases with increasing dose rate and acid concentration. Nitrobenzene but no phenol was also detected in the irradiated solutions. The results indicate that the reactions are $H_2O \rightarrow H + OH$, $HNO_3 \rightarrow OH + NO_2$, $C_6H_6 + OH \rightarrow C_6H_5 + H_2O$, $C_6H_5 + OH \rightarrow C_6H_5OH$, $C_6H_5OH + OH \rightarrow C_6H_4OH + H_2O$, and $C_6H_4OH + NO_2 \rightarrow C_6H_4(OH)NO_2$. (D.L.C.)

20062 THE EPR SPECTRUM OF PF_4 IN IRRADIATED NH_4PF_6. J. R. Morton (National Research Council, Ottawa). Can. J. Phys., 41: 706-8(Apr. 1963).

Second-order splittings predicted recently by Fessenden were observed in the EPR spectrum of NH_4PF_6 irradiated at 295°K with Co^{60} γ rays. The dominant paramagnetic fragment apparently is PF_4, but at least two other fragments appear. Isotropic hyperfine interaction constants and g values of the fragments are given. (D.C.W.)

20063 APPLICATION OF THE ELECTRON SPIN RESONANCE IN RADIATION CHEMISTRY. N. Tamura (Japan Atomic Energy Research Inst., Tokyo). Genshiryoku Kōgyō, 9: No. 2, 7-15(Feb. 1963). (In Japanese)

The fundamentals principles of electron spin resonance and its applications to radiation chemistry are discussed. The subjects reviewed include the identification of radicals and use of the method for the quantitative determination of the radicals together with the measurement of the electron spin resonance under radiation is also described. (TTT)

20064 REACTIONS OF HOT HYDROGEN ATOMS WITH HALOCARBONS. Robert A. Odum and Richard Wolfgang (Yale Univ., New Haven). J. Am. Chem. Soc., 85: 1050-6 (Apr. 20, 1963).

The reactions of hot hydrogen atoms with a series of gaseous halocarbons were studied. Recoil tritium from the nuclear reaction $He^3(n,p)H^3$ was used as the source of hot hydrogen. In monohalomethanes substitution for both halogen and hydrogen as well as hydrogen abstraction reactions appear to occur freely. The ease of displacement of halogens is in the order Br > Cl > F ≈ H. This trend correlates somewhat better with collision cross-section than bond energy. As the number of halogen substituents in halomethanes is increased, substitution for H atoms, per C – H bond, decreases moderately indicating a possible steric obstruction by the halogen atoms. There is a very sharp drop in substitution for halogen atoms in halomethanes having substituents other than that being displaced. Thus the yield of T for F substitution is much lower in CH_2F_2 than in CH_3F. The inertial factor accounts for certain hitherto unexplained trends in minor products from hot hydrogen attack on C – C bonds in alkanes. Hot hydrogen displacement of two atoms, to form a radical, is relatively prominent in monohalomethanes and even more so in dihalomethanes. The data indicate that such double substitution can proceed in a single direct displacement, although a two-step process involving dissociation of the second atom from an excited intermediate may be contributing. The reactions provide further indication of the importance of the inertial factor. The present results as well as earlier data on the absence of Walden inversion processes suggest the following generalization: substitution reactions of hot hydrogen atoms requiring the motion of heavy atoms or groups tend to be forbidden. This rule for hot atom reactions can be considered as being somewhat analogous to the Franck-Condon principle for electronic transitions. (auth)

20065 MODERATING AND REACTIVE COLLISIONS OF HOT HYDROGEN ATOMS: A STUDY ON ISOTOPE EFFECTS IN METHYL FLUORIDE. H. Clement Jurgeleit and Richard Wolfgang (Yale Univ., New Haven). J. Am. Chem. Soc., 85: 1057-62(Apr. 20, 1963).

Measurements on the isotope effect on the reaction of hot hydrogen atoms with protonated and deuterated methyl fluoride were made. Recoil tritium from the $He^3(n,p)H^3$ reaction was used as the source of hot hydrogen. The yield of total hot reaction products incorporating the tritium atom (with the exception of TF, which was not measured) was 18% lower in CD_3F than in CH_3F. Smaller variations were found in the relative yields of the various products. The results can be accounted for by either several types of isotope effects on the reactive collision, or, more simply, by a greater moderating power of CD_3F compared to CH_3F. The implications of the latter hypothesis were quantitatively examined using idealized models of the moderation process. It appears that in the energy range where hot combination reactions occur, moderating as well as reactive collisions effectively involve only a small portion of the mass of the molecule struck, although that portion is probably larger than would correspond to a single atom. It was concluded that the mean energies at which the various hot reactions take place are H abstraction < H displacement < F displacement < 2 atom displacement; the billiard ball mechanism of hot reaction is inapplicable; a possible secondary isotope effect on fluorine displacement has a magnitude less than experimental error; and no effect on hot reaction of the difference in bond strength between C – H and C – D was observed. If any such bond energy effect exists it is probably less than 5% per kilocalorie. (auth)

20066 THE RADIATION INDUCED cis-trans ISOMERIZATION OF BUTENE-2. R. B. Cundall and P. A. Griffiths (Nottingham Univ., Eng.). J. Am. Chem. Soc., 85: 1211-12 (Apr. 20, 1963).

Benzene solutions with varying concentrations of cis-butene-2 were irradiated with gamma rays from a 500-C Co^{60} source. Considerable isomerization of the butene-2 was observed, the G(trans-C_4H_8-2) values ranging from 0.18 to 2.3, the latter being the value for all solutions with butene-2 concentrations greater than 0.1M. Energies absorbed were measured by the Fricke dosimeter ($G_{Fe^{3+}}$ = 15.6). It was demonstrated that isomerization takes place by an energy transfer mechanism involving the benzene triplet. (P.C.H.)

20067 EFFECTS OF γ-RADIATION. PART VII. IRRADIATION OF 2,3-DIHYDRO-4H-PYRAN AND RELATED COMPOUNDS. A. J. Bailey, S. A. Barker, and M. Stacey (Univ. of Birmingham, Eng.). J. Chem. Soc., 1659-62(Mar. 1963).

Irradiation of aqueous solutions of 2,3-dihydro-4H-pyran in the presence of oxygen and in vacuo gave mainly tetrahydropyran-2,3-diol and tetrahydropyran-2-ol if barium carbonate was added to retain neutrality. The production of δ-hydroxyvaleric acid is explained by scission of the ether linkage, and supporting evidence is produced by studying the radiation products from tetrahydropyran. (auth)

20068 EFFECTS OF γ-RADIATION. PART VIII. IRRADIATION OF D-GLUCAL IN AQUEOUS SOLUTION. A. J. Bailey, S. A. Barker, and M. Stacey (Univ. of Birmingham, Eng.). J. Chem. Soc., 1663-6(Mar. 1963).

The effect of Co^{60} γ radiation on dilute aqueous solutions of D-glucal was studied. Hydroxylation of the unsaturated linkage to give D-glucose and D-mannose occurred on irradiation both in vacuo and in oxygen. Scission of the double bond to give D-arabinose, however, occurred to an appreciable extent only in the presence of oxygen. Evidence for these and other products is presented and a degradative mechanism is discussed. (auth)

20069 RADIATION EFFECT IN DIMETHYL-DIPHENYL SILOXANE COPOLYMER. II. EFFECT OF TEMPERATURE ON CROSSLINKING DURING IRRADIATION. Mitsuru Koike (Japan Atomic Energy Research Inst., Tokyo). J. Phys. Soc. Japan, 18: 387-96(Mar. 1963). (In English)

Crosslinkings in polydimethyl siloxane and polydimethyldiphenyl siloxane irradiated with Co^{60} γ rays were studied in the temperature range from 67° to –196°C. The G-value of crosslinking for polydimethyl siloxane depended on temperature above –100°C and the crosslinking reaction was explained by radical process; below this temperature, the G-value was not dependent on temperature and the reaction was considered to be due to non-radical process. On the other hand, the G-value of crosslinking for the polydimethyldiphenyl siloxane depended on temperature over the whole temperature range, and the reaction was due to radical

process. The relationship between crosslinking reaction and molecular motion is discussed. (auth)

20070 ELECTRON SPIN RESONANCE OF GAMMA-IRRADIATED CELLULOSE. Roland E. Florin and Leo A. Wall (National Bureau of Standards, Washington, D. C.). J. Polymer Sci., Pt. A, 1: 1163-73(Apr. 1963).

Irradiation of purified cellulose with Co^{60} gamma rays in vacuo produced moderate yields of radicals detectable by electron spin resonance. The ESR spectrum was asymmetric, with five partially resolved peaks occupying a total region of about 50 gauss wide and a spectroscopic splitting factor near g = 2. The peaks showed differing saturation behavior with increasing microwave power. Differences of crystallinity had no obvious effect on the yield or nature of the radical ESR spectrum. The presence of about 8% H_2O during irradiation decreased the yield greatly and modified the hyperfine structure. For dry cellulose the initial G value for radicals was near 2.8 radicals per 100 ev absorbed, but the concentration leveled off at doses a little over 6×10^{20} ev/g. Despite the early falling-off in yield, the radicals in stored irradiated specimens did not decay appreciably in several days. Even upon contact with air the decay was quite slow. Thermal decay was imperfectly second-order, fairly rapid above 120°C, and indicated several radicals of differing lifetimes. (auth)

20071 GRAFTING VINYL POLYMERS ONTO CELLULOSE BY HIGH ENERGY RADIATION. I. HIGH ENERGY RADIATION-INDUCED GRAFT COPOLYMERIZATION OF STYRENE ONTO CELLULOSE. R. Y.-M. Huang, B. Immergut, E. H. Immergut, and W. H. Rapson (Univ. of Toronto). J. Polymer Sci., Pt. A, 1: 1257-70(Apr. 1963).

Styrene was grafted onto cellulose in the form of cotton linters, cotton cloth, and rayon by ionizing radiation. Styrene was brought into intimate contact with cellulose by extension of the inclusion technique, and graft copolymers were prepared by exposure to high energy electrons or to gamma rays from Co^{60}. Substantial grafting was obtained by irradiation in air, nitrogen, or in vacuum. The products were purified by exhaustive extraction with benzene in a Soxhlet apparatus to remove the polystyrene homopolymer. The graft copolymers were characterized by removing the cellulose backbone by hydrolysis and determining the molecular weights of the residual polystyrene. Molecular weights of the grafted polystyrene were found to be considerably higher than those of the extracted homopolymer polystyrene or the polystyrene formed by irradiating styrene in bulk. Calculations based on the molecular weights of cellulose and polystyrene in the graft copolymer indicate that despite the substantial grafting, only one in 5000–10000 anhydroglucose units or one in 10 to 20 cellulose chains carried a grafted polystyrene chain. (auth)

20072 POLYMERIZATION INDUCED BY IONIZING RADIATION AT LOW TEMPERATURES. III. THE EFFECT OF ELECTRON DENSITY ON THE POLYMERIZATION OF SUBSTITUTED STYRENES. Catherine S. Hsia Chen (American Cyanamid Co., Stamford, Conn.). J. Polymer Sci., Pt. A, 1: 1293-303(Apr. 1963).

Solution polymerization in methylene chloride of different methyl-, methoxy- and chloro-substituted styrenes was studied both at a low temperature (–65°C) and at a higher temperature (+25°C). The rates of the m- and p-substituted monomers were correlated with the Hammett linear free-energy relationship at both temperatures and the σ^+ constants. The hypothesis that at low temperatures the polymerization mechanism is cationic and at higher temperatures the mechanism is free-radical is further supported by a negative value for ρ at –65°C and nearly zero value for ρ at 25°C obtained from the Hammett plots at the respective temperatures. Solid-state polymerizations of undiluted p-methylstyrene, o-methylstyrene, and α-methylstyrene also were investigated. It was found that the termination is unimolecular for o-methylstyrene and p-methylstyrene. The rates for α-methylstyrene at –80°C in the solid state were extremely slow. By comparing the results obtained for the solid-state and for the solution polymerizations of p-methylstyrene, o-methylstyrene, and α-methylstyrene, the hypothesis that the crystal structure plays an important role in determining the rate of solid-phase polymerization and its mechanism was further substantiated by the differences observed. The polymerization of undiluted p-methylstyrene at 0°C and at –15°C in the liquid phase and of p-methoxystyrene in methylene chloride (~3.5 moles/l) is also discussed. (P.C.H.)

20073 PREPARATION OF CARRIER-FREE Ra-228 ($MsTh_1$) AND Ac-228 ($MsTh_2$) BY ION EXCHANGE. Ernö Bruecher. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 197-200(Dec. 1962). (In Hungarian)

An ion-exchange process was developed for the production of carrier-free Ra^{228} and Ac^{228}. The Ra^{228} was produced from old $Th(NO_3)_4$. After a tributyl phosphate extraction of about 95% of the Th, the residuals were separated from the Ra^{228} on a Dowex 50 × 8 cation-exchange column in 0.5M NH_4-lactate solution. In the cation-exchange column, the Ra^{228} was bound. Rare earth impurities were removed from the column through elution by 0.7M NH_4-lactate. The Ra^{228} was eluated by 3M HNO_3 and after the solution was concentrated by evaporation, it was transferred through a 0.5 ml 0.05N HCl solution on a 0.3 × 8 cm cation-exchange column filled with Dowex 50 × 12 400 mesh resin. The Ac^{228} can be regularly eluted from the column by 0.65M NH_4-lactate, since under such conditions the adsorption zone of the Ra^{228} is shifting at a very low rate and the decomposition products Th^{228}, Pb^{212}, and Bi^{212} are eluated in precedence to the Ac^{228}. After acidification, the NH_4-lactate solution containing the Ac^{228} was carried over to a cation-exchange column from which first the Pb^{212} and Bi^{212} were eluted through 2N HCl, and then the Ac^{228} was eluted through 7N HCl. The radioactive contamination of Ac^{228} amounts to 0.2%, and its yield is 70 to 80% related to the initial Ac^{228} content of $Th(NO_3)_4$. (auth)

20074 ION-EXCHANGE SEPARATION OF LEAD (ThB) FROM BISMUTH (ThC) AND THE INVESTIGATION OF THE COMPOSITION OF THEIR LACTATE COMPLEXES. Ernö Bruecher. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 201-6(Dec. 1962). (In Hungarian)

Bi^{212} can be separated from Pb^{212} with high purity and in a rapid process through elution by 0.5M NH_4-lactate on a small-size Dowex 50 × 12 cation-exchange column. According to investigations carried out on cation-exchange and Dowex 1 × 8 anion-exchange columns, Bi^{212} and Pb^{212} appear in 0.1 to 1M NH_4-lactate solution in the respective forms of BiL_4^- and PbL^+ complexes. (L = lactate.) (auth)

20075 EFFECTS OF GAMMA IRRADIATION ON VITAMIN B_1 IN VITRO. Yori Ueno and Masasi Fukuda (Kyoto Univ.). Minerva Med., 53: 274-7(Jan. 1962).

Solutions containing up to 500 μg/ml of the vitamin in 0.001 N HCl were exposed to Co^{60} γ radiation at a dose rate of 434 rad/min. The remaining undecomposed vitamin was followed by methods employing colorimetry and polarography. Irradiation of a 1.6 mM solution (500 μg/ml) with a dose of 0.2 Mrad resulted in decomposition of 37% of the vitamin, whereas a similar dose decomposed 96% of

the vitamin in a 0.16 mM solution and 100% in a 0.016 mM solution. The degree of destruction was proportional to the dose, and, at equivalent total doses, destruction was greater at lower dose rates. Decomposition of the vitamin was partly inhibited by the presence of N_2 instead of air and completely if irradiation was carried out at 0° (in frozen solution). Addition of 1 mg/ml glutathione to the vitamin solution reduced its decomposition ~50%. In assaying the residual vitamin, greater destruction was recorded with the thiochrome fluorimetric method than with the colorimetric method employing p-aminoacetophenone. This was especially true when lower concentrations of the vitamin were used. Its decomposition could also be followed by polarography in the presence of Co^{2+} at pH 4 and by amperometry on the basis of the sulfhydryl groups. Possible mechanisms for the radioinduced decomposition of the vitamin are considered, and it was concluded that oxidation reactions involving sulfhydryl groups play an important role in the changes in the molecule. (H.H.D.)

20076 A PARAMAGNETIC SPECIES IN IRRADIATED $(NH_4)_2HPO_4$. J. R. Morton (National Research Council, Ottawa). Phys. Chem. Solids, 24: 209-12(Feb. 1963). (In English)

An oriented paramagnetic fragment was detected in single crystals of $(NH_4)_2HPO_4$ γ-irradiated at 300°K. The EPR spectra of the species are characteristic of a π-electron radical centered on a nitrogen atom. The fragment is of the form $H-\overset{+}{N}<$, its orientation in the lattice probably being determined by very weak hydrogen bonds to a phosphate ion. (auth)

20077 A DETERMINATION OF THE G-VALUE OF FERROUS SULPHATE FOR ^{60}Co RADIATION USING CALORIMETRIC DOSIMETRY. J. P. Keene and J. Law (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 8: 83-90(Apr. 1963).

A calorimeter was used to determine the absorbed dose in ferrous sulfate solution irradiated with Co^{60} γ rays. The G-value obtained for ferric ion was 15.42 ± 0.04. (auth)

20078 PRACTICAL ASPECTS OF FERROUS SULPHATE DOSIMETRY. J. V. Davies and J. Law (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 8: 91-6(Apr. 1963).

Practical details in accurate ferrous sulfate dosimetry are discussed, including a new method for estimating the extinction coefficient of Fe^{3+} ion. Errors in the ferrous sulfate G-value amounting to several per cent can arise due to the presence of impurities in the analytical reagent grade sulfuric acid normally used to make up the dosimeter solution. Simple methods of removing this difficulty are described. (auth)

20079 A COMPARISON OF IONIZATION, CALORIMETRIC AND FERROUS SULPHATE DOSIMETRY. J. V. Davies, D. Greene, J. P. Keene, J. Law, and J. B. Massey (Christie Hospital and Holt Radium Inst., Manchester, Eng.). Phys. Med. Biol., 8: 97-102(Apr. 1963).

G-values based on ionization dosimetry contain some systematic errors. These are due mainly to the presence of chemical impurity in the acid and revisions in the method of determining the absorbed dose by ionization chamber techniques. The G-values were revised and new values are given. The calorimetric and ionization chamber methods of determining the absorbed dose for Co^{60} γ rays were compared. The two methods agree to 0.3% ± 1.6% for W = 34 ev/ion pair. The G-value for Co^{60} radiation based on ionization dosimetry was found to be 15.4 ± 0.25. (auth)

20080 PARAMAGNETIC RESONANCE AND OPTICAL ABSORPTION OF IRRADIATED CaF_2:Ho. W. Hayes, G. D. Jones, J. W. Twidell (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 81: 371-3(Feb. 1, 1963).

It was shown that trivalent holmium ions at cubic lattice sites in CaF_2 trap electrons when the crystals are exposed to ionizing radiations at room temperatures and at low temperatures. After irradiation of the crystals with 50 kv x rays, an isotropic electron spin resonance spectrum was observed at 4°K with an intense eight-line hyperfine structure arising from $\Delta m_I = 0$ transitions and a weaker structure arising from $\Delta m_I = \pm 1$ transition. The spectrum arises from doubly ionized Ho^{165} on cubic lattice sites that result from the capture of electrons by Ho^{3+} ions. (C.E.S.)

20081 CO-PRECIPITATION OF CERIUM WITH K_2SO_4 CRYSTALS. II. RECRYSTALLIZATION OF PRECIPITATED K_2SO_4. S. G. Babayan, I. V. Melikhov, and M. S. Merkulova. Radiokhimiya, 4: 521-5(1962). (In Russian)

A method is suggested for verifying the Ostwald recrystallization processes of crystalline precipitates during their growth from saturated solutions. It is shown that K_2SO_4 crystals do not obey the Ostwald postulation, and the precipitated crystals have an incomplete structure. Cerium-144 was used as a tracer. (R.V.J.)

20082 ADSORPTION OF Pu(IV) ON POLISHED PLATINUM SURFACE. A. G. Samartseva. Radiokhimiya, 4: 526-31(1962). (In Russian)

With Pu(IV) concentration 10^{-9} M and hydrogen ion concentration 10^{-1} to 10^{-3} M in HNO_3 solution, the Pu(IV) adsorption on platinum reaches 97 to 98%. For pH above 4 the Pu(IV) adsorption diminishes to ~30% at pH = 7.8. The Pu(IV) adsorption process is irreversible in solutions with pH > 2.5. The 10^{-4} M concentrations of ammonium ions and La and Y ion do not effect Pu(IV) adsorption on Pt_1 while the identical concentrations of Zr(IV) strongly inhibit the adsorption process. The adsorption of Pu(IV) is greatly enhanced in solutions with H_2O_2 concentration of 10^{-2} M. (R.V.J.)

20083 ADSORPTION OF ORGANIC DYES FROM AQUEOUS SOLUTIONS BY HIGH RADIOACTIVITY BaS^*O_4 PRECIPITATES. V. V. Gromov and Vikt. I. Spitsyn. Radiokhimiya, 4: 532-6(1962). (In Russian)

Dye adsorption by $BaSO_4$ with up to 101 μC/g S^{35} activity was studied. The sorption of methylene blue diminishes and acid orange rises with the increase of $BaSO_4$ specific activity with S^{35}. The $BaSO_4$ sorptive properties change because of the positive charges produced on the surface by β emission. A prolonged activity of S^{35} β emission weakens the $BaSO_4$ sorptive properties. It was also shown that S^{35} β emission does not affect the dyes either in the solution or on the surface of radioactive precipitates. (R.V.J.)

20084 EXTRACTION OF RADIOACTIVE RUTHENIUM BY MEANS OF SODIUM PIPERIDINEDITHIOCARBAMINATES. K. V. Astakhov, S. V. Mikhaleva, and V. I. Teslin. Radiokhimiya, 4: 540-3(1962). (In Russian)

Solvent extraction of radioactive ruthenium with sodium piperidinedithiocarbaminate was studied. It is shown that in the first cycle 98% extraction is achieved. Ruthenium extraction varies only 1 or 2 percent for pH from 1.3 to 11. The optimum concentration of sodium piperidinedithiocarbaminate was 0.1 M. (R.V.J.)

20085 REACTIONS OF Br-82 RECOIL ATOMS WITH ACETIC ACID. PREPARATION OF CH_3Br AND $CH_2BrCOOH$, LABELLED BY Br-81. An. N. Nesmeyanov and E. S. Filatov. Radiokhimiya, 4: 613-15(1962). (In Russian)

Preparation of CH_3Br and $CH_2BrCOOH$ by direct 10^{12} neut/cm²sec irradiation of Br_2 + CH_3COOH showed better results than chemical synthesis. The method resulted in high yield and low impurity (4%). The carrier-free CH_3Br and $CH_2BrCOOH$ are produced by the second atom reaction of Br^{82} with CH_3COOH recoil. The tabulated data showed that with high bromine concentration in the initial mixture the yield of $CH_2BrCOOH$ diminishes but the absolute activity increases to 14 μC at ~0.1 to 0.2 M then remains unchanged. The yield of CH_3Br from the second reaction of Br^{82} recoil atoms with CH_3COOH molecules is <30%; however, with increased bromine the concentration increases continuously, explaining the easy exchange of bromine during CH_3Br gas filtration through the initial mixture at 80°: CH_3 + Br ⇌ CH_3Br + Br. The exchange reaction was used for supplementary purification of CH_3Br from Br_2. (R.V.J.)

20086 REACTIONS OF TRITIUM RECOIL ATOMS IN CYCLOHEXANE–BENZENE SYSTEMS. E. N. Avdonina. Radiokhimiya, 4: 617-19(1962). (In Russian)

Neutron irradiation of cyclohexane-benzene mixtures in the presence of Li_2CO_3 was studied in order to determine the conservation of starting materials and radiochemical yields of benzene, cyclohexene, and fractions containing hydrogen and light hydrocarbons. The results showed that the conservation of starting material does not depend on the concentration of mixtures and is stable within the experimental error. The survival of benzene is higher than that of cyclohexane. Following 30 min irradiation the conservation of benzene is 80 to 85% and cyclohexane 75 to 80%; after 20 hr it is 25 to 28 and 12 to 15%, respectively. (R.V.J.)

20087 PREPARATIONS OF THIN UNIFORM PLUTONIUM LAYERS. P. M. Aron and L. Z. Malkin. Radiokhimiya, 4: 619(1962). (In Russian)

Deposition of uniform 1.5 cm² and 30 μg thin Pu films between two or three layers of perchlorovinyl resin and colloidal layers is described. (R.V.J.)

20088 ANALYTICAL METHOD OF PROTACTINIUM-233 SEPARATION BY EXTRACTION WITH METHYLISOBUTYLKETONE. I. E. Starik, A. N. Elizarova, L. I. Il'menkova, V. N. Shchebetkovskii, M. N. Chubarov, and V. V. Smirnov. Radiokhimiya, 4: 620-2(1962). (In Russian)

Solvent extraction of Pa^{233} from irradiated thorium nitrate by methylisobutylketone was studied with prepared mixtures of thorium nitrate (2g) in 8 N HCl and various radioactive tracers (Zr^{95}, Nb^{95}, Th^{234}, U^{233}, and Pa^{233}). Mechanical shaking of 5 ml of solutions with equal amounts of methylisobutylketone separated the phases, and the concentration of radioisotopes was determined by β and α emissions. Further purification of Pa^{233} was checked by the half life (27.3 days), β emission in Al absorption, and by spectroscopy. In Pa^{233} β spectra [E_{β_1} = 0.15 Mev (37%), E_{β_2} = 0.257 Mev (58%), and E_{β_3} = 0.568 Mev (5%)] the radiochemical purity of Pa^{233} was confirmed. (R.V.J.)

20089 RAPID METHOD FOR SEPARATING RADIOACTIVE ISOTOPES OF ALKALI METALS IN ZIRCONIUM MOLYBDATES. S. S. Rodin and A. K. Lavrukhina. Radiokhimiya, 4: 623-4(1962). (In Russian)

Particles of zirconium molybdate were used as absorbents in ion exchange separation of Rb, Cs, and Fr isotopes. The elution of Rb was achieved within 5 to 6 min, followed by elution of 70% Cs^{134} within 7 to 8 min. The attempts at separating concentrated Cs and Fr fractions were not successful because of the short half life of Fr^{212} and close proximity of Cs^+ and Fr^+ ion radii. (R.V.J.)

20090 O^- RADICAL IONS ON RADIOLYSIS OF ALKALINE ICE. Dietrich Schulte-Frohlinde and Klaus Eiben (Kernforschungszentrum Karlsruhe, Ger.). Z. Naturforsch., 18a: 99-101(Jan. 1963). (In German)

An investigation using electron spin resonance was made of the appearance of O^- radical ions in gamma-irradiated alkaline ice. The results support the assumption that the OH radical in the alkaline region appears in the form of O^- radical ion. (M.C.G.)

20091 THE INDIRECT EFFECTS OF X RADIATION ON AMINO ACID. II. IRRADIATION OF TRYPTOPHAN. G. Peter and B. Rajewsky (Max-Planck-Institut für Biophysik, Frankfurt am Main). Z. Naturforsch, 18b: 110-14(Feb. 1963). (In German)

The indirect effects of x radiation in doses of 0.08 to 7.5 Mr on a 2×10^{-2} M aqueous solution of tryptophan were investigated with the help of chemical and physicochemical methods (high-voltage electrophoresis). The influences of dose, dose efficiency, temperature, and the HO_2 radicals released by reaction steps in irradiation in an oxygen atmosphere were tested qualitatively. From large numbers of the radiochemically formed decomposition products, the following could be identified with certainty: glycine, α-alanine, aspartic acid, kynurenine, 3-hydroxykynurenine, 3-oxyanthranilic acid, and tryptamine. The experimentally obtained results were tested with the help of radical effects, which pointed to a relation between decarboxylation and changes in the carbon framework. (tr-auth)

20092 RADIATION-INDUCED ADDITION OF TRITIUM TO CARBON–CARBON DOUBLE BONDS. N. S. Sundara Rajan. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 109p.

The processes involved in the radiation-induced addition and substitution of tritium to cyclohexene have been investigated. It appears that most, if not all, of the cyclohexane-T is derived from the cyclohexyl free radicals. As shown by degradation, scavenger, and phase effect studies the formation of cyclohexene-T must involve more than one pathway. Results of the irradiation of cyclohexene with tritium gas at 5 mm pressure suggest that an excited species of cyclohexene is formed which undergoes unimolecular breakdown to butadiene and ethylene. Tritiation of 3-bromocyclohexene yields chiefly cyclohexene-T labeled predominantly in the 3-4 positions. This method shows promise as a procedure for preparing labeled compounds containing a carbon-carbon double bond under the conditions of the Wilzbach method. Dehydration of cyclohexanol-1-C^{14} to cyclohexene-C^{14} by use of phosphoric acid is found to promote extensive rearrangement of the carbon skeleton. Pyrolysis of cyclohexene-1-C^{14} and cyclohexene-1-T to butadiene and ethylene does not appear to take place exclusively by the reverse Diels-Alder reaction. (Dissertation Abstr., XXIII, No. 8)

20093 A METHOD FOR PRODUCING HIGHER MOLECULAR WEIGHT FORMALDEHYDE POLYMER. (to Sumitomo Chemical Co. Ltd. and Sumitomo Atomic Energy Industries Ltd.). British Patent 921,804. Mar. 27, 1963. Priority date Sept. 24, 1960, Japan.

A method is given for producing high-molecular-weight formaldehyde polymer at high rates without a catalyst. The method comprises dispersing anhydrous formaldehyde monomer in an inert liquid which is nonsolvent for the monomer and exposing the dispersion to irradiation. The liquid is a hydrocarbon and should be 0.5 to 100 times by

weight of the monomer, and a nonionic surfactant preferably is also used. The polymerization should be carried out in the absence of oxygen. Several examples of the polymerization are given in which formaldehyde gas is blown into the inert liquid while it is being irradiated. (D.L.C.)

20094 METHOD FOR THE MANUFACTURE OF POLYMERIC TRIOXANE. (to Japanese Association for Radiation Research on Polymers). British Patent 923,154. Apr. 10, 1963. Priority date July 12, 1960, Japan.

A method is given for polymerizing trioxane in order to manufacture polyoxymethylene. The method comprises irradiating trioxane in the solid state at 30 to 62°C. The trioxane should contain less than 0.01% water, although a solvent, e.g., benzene, heptane, acetone, etc., may be used to accelerate the polymerization. Several examples of the polymerization are given. (D.L.C.)

20095 IRRADIATION ISOMERIZATION. Raymond C. Odioso, Bruce K. Schmid, and Robert C. Zabor (to Gulf Research and Development Co.). U. S. Patent 3,085,952. Apr. 16, 1963. Filed Nov. 10, 1958.

A method is described for isomerizing aliphatic paraffins, particularly those in the gasoline boiling range, in the presence of a solid catalyst and hydrogen while subjecting the reaction zone to ionizing radiation. The catalyst for the process can be any of the known solid isomerization aliphatic paraffins in the presence of hydrogen. An example of the process is given using pentane. (P.C.H.)

Separation Processes

Refer also to abstract 20203.

20096 (AERE-R-4181) THE RECOVERY OF BERYLLIUM AND URANIUM FROM BeO/UO_2 CERAMICS. B. F. Greenfield, K. R. Hyde, and F. H. Moore (United Kingdom Atomic Energy Authority. Research Group. Atomic Energy Research Establishment, Harwell, Berks, England). Feb. 1963. 14p.

Head-end methods for ceramics, such as fluorosilicate roasting at 700°C and carbonate-oxidizer leaching, were examined and compared with nitric acid ceramic leaching. These methods are not as efficient as nitric acid leaching, but the first yields Be in a water-soluble form and the second is specific for U. (auth)

20097 (DP-824) PROCESSING OF POWER REACTOR FUELS–TWENTY-FIRST QUARTERLY PROGRESS REPORT, OCTOBER 1, 1962 TO JANUARY 1, 1963. V. P. Caracciolo, comp. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Mar. 1963. Contract AT(07-2)-1. 8p.

Stainless steel cladding and Na bonding of an unirradiated partial assembly from the Hallam (Nebraska) reactor were successfully dissolved electrolytically in nitric acid. Zirconium oxide sludge produced during the electrolytic disintegration of Zircaloy was continuously removed from the dissolver. A nonconducting basket of laminated glass fabric and silicone resin used to hold fuel assemblies during electrolytic dissolving failed after 100 hours. These tests were made in a continuing program to confirm the capacity of the 5000-amp dissolver for power fuels clad with stainless steel or Zircaloy. (auth)

20098 (HW-75447) SOLVENT EXTRACTION OF CESIUM BY DIPICRYLAMINE. III. SEMIWORKS DEMONSTRATION. G. L. Richardson (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 15, 1963. Contract AT(45-1)-1350. 15p.

The extraction and recovery of cesium from simulated Purex waste solutions was successfully demonstrated in the pilot plant pulse column. Stable volumetric capacities as high as 670 gph/ft^2 (sum of both phases) were obtained for alkaline supernate-type waste; however, for efficient operation (transfer unit height–HTU–of two feet or less), the maximum throughput rate was limited to about 500 gph/ft^2. This rate could be achieved with feeds diluted to densities within 0.08 g/cc of the solvent density. Stable feed was prepared from simulated current, denitrated waste by addition of citric acid to complex the iron before neutralization to the desired operating pH of 7 to 8. Capacities of 500 gph/ft^2 were readily achieved with this feed, together with HTU's of 1.0 to 1.3 feet. Sodium extracted with the cesium was satisfactorily scrubbed from the solvent with a dilute citric acid solution. Scrub section sodium decontamination factors (DF's) as high as 200 were measured, but decontamination factors of 10 to 40 were more nearly typical. These scrub section DF's, coupled with the normal sodium DF of about 200 on extraction, gave overall sodium decontamination factors of 2,000 to 40,000. The overall potassium decontamination factors were 75 to 500, based on a very limited number of runs. Cesium was stripped from the solvent with 0.125 to 0.5 M HNO_3. Typical HTU's were in the range of 1.1 to 1.6 feet. The column capacity was in excess of 800 gph/ft^2. A packed column containing $^3/_4$-inch stainless steel Raschig rings provided capacities at least as high as the pulse column; however, the efficiency, even with air sparge agitation, was considerably lower. The HTU's were generally about twice as great as obtained with the pulse column at comparable flow rates. (auth)

20099 (MITNE-30) THE EFFECT OF ALKYL AMINE TYPE ON THE EXTRACTION OF NITRIC ACID AND NITROSYLRUTHENIUM NITRATO COMPLEXES. Tom H. Timmins and Edward A. Mason (Massachusetts Inst. of Tech., Cambridge). Apr. 1, 1963. (For Oak Ridge National Lab., Tenn.). Contract W-7405-eng-26; Subcontract 1327. 116p.

An investigation of the solvent extraction characteristics of nitric acid and the nitrato complexes of nitrosylruthenium was conducted, using alkyl amines as extractants. The alkyl amines used were a primary amine Primene JMT, a tertiary amine trilaurylamine (TLA), and a quaternary amine Aliquat 336. The organic phase concentrations of HNO_3 resulting during extraction by alkyl amines were found to correlate well on the basis of the undissociated aqueous HNO_3 activity for both salted ($NaNO_3$) and unsalted aqueous phases. The distribution ratios for Ru extraction showed better correlation on this basis than on the basis of aqueous phase nitrate and nitric acid. The order of decreasing Ru extraction at low HNO_3 concentration (2N) was found to be Aliquat 336, TLA, and Primene JMT. At high HNO_3 concentration (9N), Primene JMT had the highest Ru extractability. Rapid dilution experiments were utilized to determine the number and aqueous phase concentrations of the extractable species of Ru, and the amine partition coefficients for the species. It was found that two Ru species are extractable, and the more extractable species is present in the aqueous phase at lower concentration than the less extractable species. The mole fractions of both species were found to increase with increasing HNO_3 concentration. The TLA partition coefficients for the extractable species were found to decrease with increasing HNO_3 concentration. The quaternary amine, Aliquat 336, was found

to have partition coefficients an order of magnitude greater than the tertiary amine, TLA. Equations for the mole fractions and TLA partition coefficients in the region of HNO_3 concentration investigated were developed. (auth)

20100 (ORNL-TM-412) CHEMICAL TECHNOLOGY DIVISION. UNIT OPERATIONS SECTION MONTHLY PROGRESS REPORT, OCTOBER 1962. M. E. Whatley, P. A. Haas, R. W. Horton, A. D. Ryon, J. C. Suddath, and C. D. Watson (Oak Ridge National Lab., Tenn.). Apr. 29, 1963. Contract [W-7405-eng-26]. 64p.

A method for measuring drop lifetime in coalescence experiments by using an interrupted light beam is accurate to within 0.01 sec. Recovery of most of the dodecylbenzenesulfonate foaming agent in a foam separation operation can be effected by an additional foaming step. Foam separation of Sr from low-level waste was inhibited by the presence of a commercial detergent. The effective neutron cross sections for Pa^{231}, Pa^{232}, and U^{232} were determined from the yield of an irradiation experiment using Pa^{231}. Particle-size measurements were made of sheared pieces of UO_2-filled Mark I prototype fuel elements for the shear and leach program. The shearing of Mark I prototype fuel elements embrittled by carburization produced more dislodged material than the shearing of nonembrittled assemblies. Leaching of sheared UO_2 stainless steel pieces in the shear and leach program was highly dependent on the acid flow path, and dissolution rate varied linearly with HNO_3 concentration. Recycled fused salt was used for 8 successive dissolutions of Zircaloy-2 simulated fuel elements in volatility process development. High-level-waste calcination development run 68 using simulated TBP-25 waste fed from a gravity head tank is reported. (auth)

20101 (ORNL-TM-543) SEPARATION OF PROTACTINIUM FROM THORIUM IN NITRIC ACID SOLUTIONS BY SOLVENT EXTRACTION WITH TRIBUTYL PHOSPHATE OR BY ADSORPTION ON PULVERIZED UNFIRED VYCOR GLASS OR SILICA GEL. J. G. Moore and R. H. Rainey (Oak Ridge National Lab., Tenn.). Apr. 8, 1963. Contract [W-7405-eng-26]. 27p.

Two methods were investigated for the separation and recovery of Pa from short-decayed Th fuel in HNO_3 solutions. The Pa^{233}, Th, and U may be coextracted from highly acidic feed solutions with 30% tributyl phosphate, or the Pa may be preferentially adsorbed on pulverized unfired Vycor glass or silica gel. Major effort has been on the adsorption method. Adsorption experiments with tracer concentrations of Pa^{233} in HNO_3 solutions showed distribution coefficient maxima for Pa of about 1000, 325, and 175 from 6 to 10 M HNO_3 for laboratory-prepared silica gel, unfired Vycor, and commercial silica gel, respectively. Unfired Vycor, a commercial, leached borosilicate glass containing 96% SiO_2 and about 3% B_2O_3, was used for most of the studies. Fired Vycor glass adsorbed little or no Pa. The adsorption coefficient of Pa by unfired Vycor glass from HNO_3 solutions increased as the contact time increased or as the particle size of the glass decreased and was dependent on the concentration of salt or HNO_3 in the solution. The adsorbed Pa may be eluted with oxalic or tartaric acids. Although optimum conditions for column operations were not determined, decontamination factors of Pa from Th, U, Ru, Zr–Nb and total rare earths of 6×10^3, 1.6×10^4, 4×10^3, 3, and 5.8×10^5, respectively, were obtained in tracer experiments. Batch countercurrent scouting experiments with tracer Pa showed that about 90% of the Pa was extracted with the Th and U from 5 M HNO_3—1 M $Al(NO_3)_3$ solutions, with a decontamination factor of 70 from Ru and about 10^5 from rare earths. (P.C.H.)

20102 (ORNL-TM-563) EUROCHEMIC ASSISTANCE PROGRAM PROGRESS REPORT FOR JULY–DECEMBER 1962. E. M. Shank (Oak Ridge National Lab., Tenn.). Apr. 9, 1963. Contract [W-7405-eng-26]. 44p.

The Eurochemic staff was expanded to about 195 people; this expansion will continue until the authorized complement of 450 people is reached. The pre-project designs were completed for all facilities. The plant capacity remains as previously reported except for the Pu facility, which was reduced from 3.0 to 1.5 kg/day. A revised cost estimate made in Sept. 1962 gives a construction cost of 24.67 million dollars with an additional 6.03 million dollars operating cost through 1963. The civil engineering design is about 80% complete and construction is about 50% complete; building construction is about six months behind the schedule anticipated in Nov. 1961. The main process consists of two solvent extraction cycles of a Purex-type flowsheet. The Pu facility is being designed to use a 30% TBP flowsheet. A new French stainless steel, Uranus S, is being evaluated as a material for waste evaporators. Two special studies were made relative to the processing of enriched U on the Eurochemic site; a final decision from the Board is expected by July 1963. The Board has authorized the management to start preliminary processing contract negotiations. (auth)

20103 SYSTEMATIC STUDY OF THE SOLVENT EXTRACTION OF METAL β-DIKETONATES. Jiří Starý and Eduard Hladký (Faculty of Technical and Nuclear Physics, Prague). Anal. Chim. Acta, 28: 227-35(Mar. 1963). (In English)

The extraction of 30 metals (Be, Mg, Ca, Sr, Ba, Sc, La, Ti, Zr, Th, Cr, Mo, U, Mn, Co, Fe, Ni, Pd, Cu, Ag, Zn, Cd, Hg, Al, Ga, In, Tl, Sn, Pb, and Bi) by solutions of acetylacetone, benzoylacetone, and dibenzoylmethane in benzene was studied in relation to the pH values for extraction. The extraction constants and two-phase stability constants of the β-diketonates were calculated; these can be used to determine the optimum conditions for the separation of many metals. The linear relationship between the distribution coefficients of β-diketones and their corresponding β-diketonates was confirmed. (auth)

20104 THE SEPARATION OF Lu, Yb, AND Tm ON CATION-EXCHANGE RESIN WITH α-IHBA AS ELUANT. D. L. Massart and J. Hoste (Université, Ghent). Anal. Chim. Acta, 28: 378-82(Apr. 1963). (In French)

The mutual separation of Lu, Yb, and Tm is examined with cation-exchange resin and 0.1 M α-hydroxybutyric acid as eluant. When carrier amounts of ~1 mg of rare earths are eluted, the distribution constants are displaced and the elution peaks are asymmetrical. Quantitative separation is, however, possible at room temperature; separation requires 23 hr at pH 3.83 but only 13 hr with a pH gradient. (auth)

20105 STUDY OF ION EXCHANGE EQUILIBRIUM OF RARE EARTHS WITH THE COMPLEX SOLUTION OF HEAVY METALS AND AMINOCARBOXYLIC ACIDS. Haruo Natsume (Centre d'Etudes Nucleaires, Saclay, France). Bull. Chem. Soc. Japan, 36: 4-20(Jan. 1963). (In French)

Solutions containing complexes of Co^{2+} with ethylenediaminetetraacetic acid are prepared, and their equilibrium reactions with Sm and Eu on ion exchange columns are studied. The ion exchange resin is used principally in the form of the ammonium salt. The reactions are followed by means of beta and gamma spectroscopy of active Sm and Eu isotopes. (T.F.H.)

20106 SEPARATION OF THE RARE EARTH ELEMENTS FROM URANIUM FISSION PRODUCTS BY PAPER ELECTROPHORESIS. D. Imrišová and V. Knobloch (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 331-9 (Feb. 1963). (In German)

The separation of the rare earth elements by paper electrophoresis in tartaric, citric, or lactic acid media was investigated. The separation was carried out on an isotopic mixture of the rare earths separated from uranium fission products and on an artificial mixture. The possibility of using the focusing ion exchange method for the rapid separation of the individual elements of the rare earths was also studied. (tr-auth)

20107 PRECIPITATION OF URANIUM FISSION PRODUCTS AND ISOLATION OF CESIUM. J. Elder and V. Kouřím (Inst. for Experimental Botany, Czechoslovak Academy of Sciences, Prague and Inst. for Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 530-4(Feb. 1963). (In German)

A method for the decontamination of solutions of aged fission products by the precipitation of a hydroxide-carbonate-dipicrylaminate mixture was proposed. The volume of extremely radioactive wastes was greatly reduced, and its storage or disposal was simplified. From the precipitation of the corrosion and fission products, the Cs^{137} was isolated by extraction of dipicrylaminate with acetone. Further purification is possible. (tr-auth)

20108 RADIOCHEMICAL ISOLATION. II. CHROMATOGRAPHIC ISOLATION OF RARE EARTHS. M. Vobecký and A. Maštalka (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 709-15(Mar. 1963). (In German)

The optimal conditions for the isolation of all lanthanides without carriers or with high specific activity by means of chromatography on a cation exchanger, especially with regard to quick isolation and radiochemical purity of the products, were found. The uniform scrubbing of the lanthanides from the acid was obtained by means of a concave concentration gradient of isobutyrate solution. The distribution factors for the separation of the pairs Tm–Er, Er–Ho, Nd–Pr, Pr–Ce, and Ce–La were determined at pH 4 to 4.8 at 25°C. A simple arrangement for the preparation of the concave gradient is described that is especially suited for work with radiation. (tr-auth)

20109 RADIOCHEMICAL ISOLATION. III. INFLUENCE OF ENVIRONMENT ON CHROMATOGRAPHIC ISOLATION OF LATHANIDES. A. Maštalka, M. Vobecký, and O. Vojtěch (Inst. for Nuclear Research, Czechoslovak Academy of Sciences, Řež). Collection Czech. Chem. Commun., 28: 743-5(Mar. 1963). (In German)

The effects of dioxane, methanol, acetone, and pyridine on the chromatographic separation of lanthanides using ammonium-α-hydroxyisobutyrate solution were studied. All these compounds were found to improve separation. (M.C.G.)

20110 STUDIES ON THE EXTRACTION OF NIOBIUM, TANTALUM, AND URANIUM FROM SAMARSKITE. T. R. Bhat, Y. W. Gokhale, and B. S. Mathur (Atomic Energy Establishment, Trombay, India). Indian J. Technol., 1: 165-9(Apr. 1963).

The extraction of Nb, Ta, and U from samarskite was studied using different methods, such as alkali fusion followed by hydrochloric acid treatment; alkali fusion and sulfuric acid leaching; direct reaction with concentrated sulfuric acid; and fusion with ammonium fluoride and ammonium bifluoride. Optimum conditions were determined for each treatment. Solvent extraction with methyl isobutyl ketone from 9 N sulfuric acid–5 N hydrofluoric acid mixture gave satisfactory separation of Nb and Ta oxides. Niobium and tantalum oxides of ~99.9% purity were prepared in kilogram quantities by the method. (auth)

20111 POLY-(1-HYDROXY-4-VINYLPYRIDINIUM) ANION-EXCHANGERS. A. Heller, Y. Marcus, and I. Eliezer (Israel Atomic Energy Commission Labs., Rehovoth). J. Chem. Soc., 1579-82(Mar. 1963).

Cross-linked poly-(1-hydroxy-4-vinylpyridinium) ion exchangers were prepared in an attempt to utilize the specificity that N-oxides show to heavy metals, and to U in particular. However, the polymers obtained behaved as ordinary anion exchangers, somewhat less basic than Dowex 2. The main advantage of the new exchanger is its high exchange rate. (auth)

20112 THE EXTRACTION OF THORIUM FROM SULFURIC ACID SOLUTION BY N-CYCLOHEXYL-n-ALKYLAMINES. Ichiro Yagi (Asahi Electro-Chemical Co. Ltd., Tokyo). Kogyo Kagaku Zasshi, 65: 27-9(Jan. 1962).

The influence of the substituent alkyl radical on the extraction of Th from sulfuric acid solution by N-cyclohexyl-n-alkylamines in benzene was studied. The amines used were: N-cyclohexyl-n-octyl (C_8), -n-decyl (C_{10}), -n-dodecyl (C_{12}), -n-tridecyl (C_{13}), -n-tetradecyl (C_{14}), -n-hexadecyl (C_{16}), and -n-octadecyl (C_{18}) amine. When in contact with the aqueous phase, C_8 formed a third liquid phase, C_{16} and C_{18} formed emulsions, and C_{10}, C_{12}, C_{13}, and C_{14} showed excellent phase separation. Relations found among the C_{10}, C_{12}, C_{13}, and C_{14} derivatives were: at an acid concentration of 0.1 to 1.0 N (H_2SO_4 in aqueous phase), $\log K_{d(Th)} = \text{const.} - 2 \log [H_2SO_4]$; at a Th concentration of 0.0003 to 0.03 mole/l, $\log K_{d(Th)} = \text{const.} - 0.75 \log [Th]$; at an amine concentration of 0.1 to 0.6 mole/l, $\log K_{d(Th)} = \text{const.} + 2 \log [\text{amine}]$; K_d of Th increases in the order of C_{10}, $C_{12} \leq C_{14} < C_{13}$; the extractability of H_2SO_4 increases the order of C_{10}, $C_{12} \leq D_{14} < C_{13}$; and Th may be extracted as $(RR'NH \cdot H)(Th(SO_4)_3)$. (H.H.D.)

20113 CHROMATOGRAPHY IN EXTRACTION PROCESSES. B. K. Preobrazhenskii and G. S. Katykhin. Radiokhimiya, 4: 536-40(1962). (In Russian)

A chromotographic extraction method with the organic phase fixed as a film on fluoropolymer powder in a column was studied. Data are presented on Nb and Zr separation on a teflon column by 0.5 M thenoyltrifluoro acetone in benzene and In and Tl in a fluoropolymer column with isoamylacetate. (R.V.J.)

20114 EFFECTS OF DILUENT PROPERTIES ON URANYL NITRATE EXTRACTION BY TRIBUTYL PHOSPHATE. M. F. Pushlenkov, E. V. Komarov, and O. N. Shuvalov. Radiokhimiya, 4: 543-50(1962). (In Russian)

The effect of the diluent on distribution coefficients for uranyl nitrate between aqueous and organic phases was studied. A calculation was made of water and TBP association constants in chloroform, dichloroethane, carbon tetrachloride and bromobenzene. It was found that the variations in TBP extraction ability are not specified by diluent polarity. (R.V.J.)

20115 THE MECHANISM OF EXTRACTION PROCESSES. IV. SOLVATION AND HYDRATION OF URANYL NITRATE IN BENZENE–SIMPLE ETHER SOLUTIONS. R. H. Maslova and V. V. Fomin. Radiokhimiya, 4: 550-60 (1962). (In Russian)

Solvent extraction of uranyl nitrate by solutions of benzene in simple ethers (dibutyl, dipropyl, ethylpropyl and methylbenzyl) was studied. It was found that with constant aqueous phase equilibrium the uranyl nitrate coefficient logarithm shows a linear dependence on the molar fraction of free extraction agent. It was also found that the dilution of benzene with ether reduces the number of water molecules hydrating uranyl nitrates in the organic phase. A correlation of solvate and hydrate numbers revealed the total amount of uranyl nitrate hydrosolvates. (R.V.J.)

20116 TEMPERATURE EFFECTS ON URANYL STATE IN NITRIC ACID SOLUTIONS. B. G. Pozharskii. Radiokhimiya, 4: 561-70(1962). (In Russian)

The dependence of uranyl absorption spectra on the nitric acid concentration at various temperatures was studied in order to determine the complexing of uranyl with nitrate ions as a function of temperature. A rise in temperature at nitric acid concentration up to 4 N increases the complex formation with nitrate ions. An increase in temperature at 6 N nitric acid does not affect the complexing. It was found that uranyl ions in aqueous solutions have a structure $[U(OH)_4]^{2+}$ in addition to the $[UO_2(H_2O)_2]^{2+}$. The neptunyl, plutonyl, and americyl ions were also constructed. The OH groups form plane covalent complexes with Me(VI) in the center by means of f^3d-hybrid bonds. The stability of aqueous solutions drops from uranyl to americyl due to the increased number of bare f-electrons. (R.V.J.)

20117 COMPLEXING OF AMERICIUM WITH NEUTRAL PHOSPHOROORGANIC COMPOUNDS. [PART] I. V. I. Zemlyanukhin, G. P. Savoskina, and M. F. Pushlenkov. Radiokhimiya, 4: 570-5(1962). (In Russian)

Studies of americium extraction by phosphoroorganic compounds (tri-n-butyl-phosphate, di-n-butyl ester of n-butyl phosphonic acid, n-butyl ester of di-n-butylphosphinic acid, and tri-n-butyl phosphine oxide) showed that americium and neutral phosphoroorganic compounds form americium trisolvate: $Am(NO_3)_3 \cdot TBP$, $Am(NO_3)_3 \cdot 3DBEBP$, $Am(NO_3)_3 \cdot 3BEDBP$, and $(AmNO_3)_3 \cdot 3TBPO$. Complexing constants for the above compounds are: $K_{TBP} = 0.4$, $K_{DBEBP} = 7.4$, $K_{BEDBP} = 112$, and $K_{TBPO} = 1780$. (R.V.J.)

20118 TEMPERATURE EFFECTS ON EXTRACTION BY TRIBUTYL PHOSPHATES. A. M. Rozen, L. P. Khorkhorina, S. M. Karpacheva, and G. D. Agashkina. Radiokhimiya, 4: 591-600(1962). (In Russian)

Temperature effects on a combined distribution of uranyl nitrate and nitric acid during TBP extraction at acidity up to 8.0 M and uranyl nitrate concentration from 0 to 1.0 M in aqueous solutions were studied at 20, 40, and 70°C. It was found that the distribution constants for uranyl nitrate diminish with the temperature and for nitric acid remain unchanged. At constant initial content of uranium and acid a smaller amount of uranium and a larger amount of acid transfer into the organic phase (thus, increasing the concentrations of free TBP and nitric acid). (R.V.J.)

20119 FORMATION OF SECOND ORGANIC PHASE IN URANYL NITRATE EXTRACTION BY TRIOCTYLAMINE SOLUTIONS IN CARBON TETRACHLORIDE. V. M. Vdovenko, T. V. Kovaleva, and M. A. Ryazanov. Radiokhimiya, 4: 609-10(1962). (In Russian)

Formation of two organic phases was observed during uranyl nitrate extraction from 1 N HNO_3, 0.185 M trioctylamine solutions in carbon tetrachloride at 25°. The two phases were observable only with a high $UO_2(NO_3)_2$ concentration in equilibrium aqueous phase (>1.5 M). The two-phase analysis of uranium and amine and the ratio of the number of amine moles to the $UO_2(NO_3)_2$ number of moles in the second phase are tabulated. The table shows that with the increase of $UO_2(NO_3)_2$ concentrations of amine and uranium rise in the second organic phase and diminish respectively in the first phase. Simultaneously the number of amines per one uranyl nitrate mole is reduced in the second phase resulting in additional uranium extraction into the phase. (R.V.J.)

20120 EXTRACTION OF HYDROFLUORIC ACID AND URANYL FLUORIDE BY TRI-N-NONYLAMINE SOLUTION IN BENZENE. V. M. Vdovenko, M. P. Koval'skaya, and E. A. Smirnova. Radiokhimiya, 4: 610-11(1962). (In Russian)

Additional data are given on experiments carried out with extraction of uranyl salts and mineral acids by tri-n-nonylamine and tri-n-decylamine solution in benzene previously reported by V. M. Vdovenko et al. (Radiokhimiya 3.4, p.403(1961)). The distribution of hydrofluoric acid and uranyl fluoride between aqueous solution and TNA solution ($T_a = 206 - 7/1$ mm, $n_D^{20} = 1.4518$, $d_4^{20°} = 0.8214$) in benzene was analyzed and tabulated. The data on uranium extraction from nitrate and chloride solutions indicate that with an increased uranium concentration in the initial aqueous solution, the distribution factor diminishes with the reduced concentration of free amines. (R.V.J.)

20121 ION EXCHANGE OF $(C_2O_4)^{2-}$ IN U(IV) AND URANYL OXALATE COMPLEXES. A. A. Grinberg, D. N. Bykhovskii, and I. K. Petrova. Radiokhimiya, 4: 611-13(1962). (In Russian)

Ion exchange of $(C_2O_4)^{2-}$ in U(IV) and uranyl complexes was studied using two methods. The first method was carried out by precipitating $[U(C_2O_4)_4]^{4-}$ anion by complex cation $[Cr(CON_2H_4)_6]^{6+}$. A fine crystalline precipitation is initiated by addition of chromium hexacarbamide chloride solution to the $K_4[U(C_2O_4)_4]$ solution. The precipitate contains 19.8% U, 29.3% C_2O_4, 39.8% CON_2H_4 (in nitrogen), and 6.0% H_2O. The formula is $[Cr(CON_2H_4)_6]_4\,[U(C_2O_4)_4]_3 \cdot 12\,H_2O$. The order of accuracy for measurements with C^{14} is 5%. The second method was carried out with a small part of free zinc oxalate. Preliminary experiments showed that zinc oxalate does not capture uranium x_1, and the large crystals do not react with oxalate ions. Only the second method was used for the $Na_2[UO_2(C_2O_4)_2] + Na_2C_2^{14}O_4$ system where the uranyl complex was $[UO_2(C_2O_4)_2(H_2O)_2]^{2-}$. The tabulated data indicate a rapid exchange for the first and second method and systems. (R.V.J.)

20122 SOLVENT EXTRACTION OF TRANSITION METALS FROM THIOCYANATE SOLUTIONS. Renato G. Bautista and Robert A. Hard (Massachusetts Inst. of Tech., Cambridge). Trans. AIME, 227: 124-30(Feb. 1963).

A comparative study was made of the extractability of several of the transition metals from thiocyanate solutions using methyl isobutyl ketone as the organic solvent. Extractions were made of Sc(III), Cr(III), Mg(II), Fe(III), and Co(II), of which only the Sc, Fe, and Co were readily extracted. All extractions were made at pH 2 and 25.5°C. A series of extraction experiments was made on Sc, Fe, and Co to determine the effect of thiocyanate concentration added as the ammonium and also as the calcium salt. Also determined was the effect of metal ion concentration and ionic strength on the distribution ratio. Analyses of the organic extracts indicated the Sc and Fe were extracted principally in the uncharged trithiocyanate form, while the extractable form of the Co contained the cobaltotetrathiocyanate anion. (auth)

20123 REPROCESSING FAST REACTOR FUELS AT DOUNREAY. D. M. Donaldson (United Kingdom Atomic

Energy Authority, Thurso, Caithness, Scotland), K. Hartley, P. Lees, and N. Parkinson. Trans. AIME, 227: 191-202 (Feb. 1963).

The reprocessing of advanced fuels such as carbides, oxides, and cermets, containing up to 30% Pu was studied. Dissolution of uranium carbides in nitric acid produces appreciable quantities of mellitic acid that has undesirable effects in subsequent stages of the process. Mixed oxides containing up to about 40% Pu in solid solution with UO_2 are soluble in nitric acid and a leaching type process in nitric acid for a stainless steel/UO_2. PuO_2 fuel containing 30% Pu appears to be feasible. It offers considerable economic advantages over total dissolution routes. A new oxidation-sublimation process is described for metallic fuels containing up to 12% Mo. New data are presented on the solvent extraction of U and Pu nitrates into tributyl phosphate–odorless kerosene and of the influence of radiolytically produced acid phosphates on this part of the process. It was concluded that there are no insuperable difficulties that will prevent the satisfactory reprocessing of high burn-up Pu fuels by a solvent extraction route. (auth)

20124 PRODUCTION OF BERYLLIUM FLUORIDE. Leslie Jack Derham (to National Smelting Co. Ltd.). British Patent 922,523. Apr. 3, 1963. Filed Oct. 10, 1960.

A process is given for treating siliceous beryllium ores for the production of beryllium fluoride. The process comprises contacting the ores with a HF–steam mixture at 200 to 300°C, leading the SiF_4 off, and leaching the residue to recover the beryllium. The process proferably is carried out in a fluidized bed, and HF is recovered from the SiF_4 by decomposition with water vapor at >600°C. (D.L.C.)

ENGINEERING AND EQUIPMENT

General and Miscellaneous

Refer also to abstracts 19727, 20189, 20667, 20668, 21249, and 21250.

20125 (CEA-2249) UTILISATION DE LA TENSION SUPERFICIELLE D'UN LIQUIDE DANS LA REALISATION D'UN EVAPORATEUR A NIVEAU CONSTANT. (Use of Liquid Surface Pressure in the Achievement of a Constant Level Evaporator). Andre Fonseca (France. Commissariat a l'Energie Atomique. Centre d'Etudes Nucleaires, Grenoble). 1963. 7p.

An evaporator is described that consists mainly of a tank and an evaporation cup. The liquid contained in the tank runs out into the cup with a flow varying only as the speed at which evaporation is going on. The level of the liquid in the cup remains constant according to the laws of hydrostatics. What is original in such a device is the use of surface pressure of the liquid to be dried off. Thanks to this pressure the whole tank is above the constant level, which allows it to be entirely drained off into the evaporation cup. The property used there also makes it possible to use a simple device (pressure contactor and relay) to cut heating off automatically when evaporation is nearly finished. (auth)

20126 (NOLTR-62-45) A METHOD FOR MEASURING INTERNAL BLAST PRESSURE-TIME HISTORIES OF CONFINED, SODIUM-CASED EXPLOSIONS. Harry B. Benefiel (Naval Ordnance Lab. Explosives Research Dept., White Oak, Md.). Aug. 9, 1962. 34p. (AD-400241)

A method for measuring internal blast pressure-time histories from sodium-cased explosions in an oxygen-depleted atmosphere within a closed piston-fitted vessel was developed, and histories for 48 experiments in an idealized $^1/_{30}$-scale model of the Enrico Fermi Nuclear Reactor were measured. The measurements were made with a newly developed pressure-measuring system utilizing a recording oscilloscope and an electro-mechanical, variable-reluctance pressure gage coupled with a fluid-filled, pressure-transmitting tube. A method is also presented for evaluating confidence in the validity of the experimental results. Pressure-time data for 21 of the experiments are tabulated and evaluated for validity. (auth)

20127 (TRG-Inf-Ser-18) THE INFLUENCE OF POWER FACTOR IMPROVEMENT ON LOAD STABILITY. V. A. Venikov. Translated by C. A. Routledge. (U.K.A.E.A. Atomic Energy Research Establishment, Harwell, Berks, Eng.) from Elektrichestvo, No. 6, 6-10 (1960). 7p.

The effect on load stability of using static condensers to improve the power factor is examined. The case of a system of asynchronous motors is treated. Criteria for load stability are derived, and two examples are discussed. (D.C.W.)

20128 (UCRL-Trans-936(L)) DETERMINING THE TENSOR OF PRESSURE BUILDUP DURING BLAST BY EXPERIMENTAL SEISMIC INVESTIGATION DATA. M. A. Mikulinskii and P. S. Mironov. Translated by Sergey Shewchuck (Univ. of California Lawrence Radiation Lab., Livermore) from Izv. Vysshikh Uchebn. Zavedenii, Gorn. Zh., No. 11, 69-72(1960). 8p.

A method for calculating the tensor of stresses (pressure buildup) in a structure from seismic data is presented. Formulas for the tensor of stresses are derived for spherical waves, and the case in which the spherical wave can be considered approximately flat is considered. From the tensor of stresses of a structure, the structure's stability can be determined. (D.C.W.)

20129 ANNULAR-BEAM ION ENGINES. J. R. Anderson, J. E. Etter, and H. E. Gallagher (Hughes Research Labs., Malibu, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 582-6(Mar. 1963).

The strip-beam cesium contact ion engine forms a major class of electrostatic propulsion engines that develop thrust by means of the acceleration of charged particles. This strip configuration offers a number of fundamental advantages compared to other forms of ion engines, including higher current density, ease of fabrication, high overall thrust density, etc. Such ion engines, built in the forms of multiple linear strips and circular strip or annular configurations, were built and operated. Some of the considerations entering into the design of efficient engines of this type are presented, performance achieved to date on a small circular form of this strip engine is quoted, and preliminary results of some more advanced forms of engines are described. The emphasis is on the circular strip or ring type of ion engine and particularly on such an engine that was developed for an early flight test demonstration. Future improved performance from this type of ion engine also is indicated, based on the experience to date. (auth)

20130 METALS DEVELOPMENT PROCESS INTEGRATED WITH AIR CONDITIONING AT AEC'S AMES LAB. Robert W. Flanagan. Heating, Piping Air Conditioning, 34: 97-102(July 1962).

High air requirements, varying loads, controlled interior pressure relationships, and limitations imposed by building design were the complicating factors in providing air conditioning for the Atomic Energy Commission's new metals development lab at Ames, Iowa. A split air and water system was the answer. An interesting feature of this system is that by using the absorption machine as a condenser in the lab's distilled water process as well as to provide air conditioning, equipment and operating costs were minimized. A detailed description of the design and control of this installation is presented. (auth)

20131 DEVELOPMENT OF A HIGH TEMPERATURE LIQUID METAL TURBOPUMP. R. W. Kelly, G. M. Wood, and H. V. Marman (Pratt and Whitney Aircraft, Middletown, Conn.). J. Eng. Power, 85: 99-107(Apr. 1963).

High-performance, mobile nuclear power plants utilizing liquid metals require high-temperature pumps to circulate these heat transport fluids. These pumps must have moderately high efficiency, small size, low weight, and high reliability. In order to satisfy these requirements, centrifugal pumps directly coupled to gas turbines are utilized. As part of the aircraft nuclear power plant development program, a 3000-gpm stainless steel turbopump was designed and tested in NaK at temperatures up to 1300°F. (auth)

20132 LARGE ROTARY VACUUM SEAL. D. E. Armstrong and Normand Blais (Los Alamos Scientific Lab., N. Mex.). Rev. Sci. Instr., 34: 440-1(Apr. 1963).

A seal is described which permits rotation of large circular sections or ports in the walls of a vacuum chamber. The seal is an unlubricated Tec-Ring (a Teflon O-ring with a core of rubber), and the friction is low even at large diameters. The behavior of such a seal is compared with that of a lubricated Neoprene or Silastic O-ring. (D.L.C.)

20133 GLASS-TO-METAL TUBE CONNECTOR FOR VISUAL OBSERVATION OF THE EFFECT OF PRESSURE ON PHASE EQUILIBRIA. James S. Gill and William L. Marshall (Oak Ridge National Lab., Tenn.). Rev. Sci. Instr., 34: 442-3(Apr. 1963).

A glass-to-metal tube connector was developed in order to know the pressure and its effect on the phase equilibria of a system and to eliminate the vapor phase. A Teflon gasket was used as the seal between glass and metal. The connector was used successfully to pressures of 300 to 350 bars. The effect of pressure on the temperature of two-liquid-phase formation in 2.60 molal UO_2SO_4 in H_2O is shown for pressures up to 300 bars. (D.L.C.)

20134 THE ULTRACENTRIFUGE. Peter Eugen Hexner. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 149p.

The recent undertakings in the field of ultracentrifugation at the University of Virginia with a magnetically suspended ultracentrifuge are described. These include molecular weight studies, the effects of solvents and temperature on the ideality of polymer solutions, improvements on both the ultracentrifuge and associated apparatus, determinations of molecular weight distributions in polydisperse systems, a new technique for rapid attainment of sedimentation equilibrium, and comparison experiments with three ultracentrifuges, namely an L.K.B. direct drive, Spinco Model E, and the magnetically suspended ultracentrifuge. The experimental results obtained indicate the following: (1) The magnetically suspended ultracentrifuge with associated apparatus can be used to determine molecular weights of substances in the 10^2 to 10^7 molecular weight range with great precision. (2) Apparent molecular weights obtained at non-theta temperatures with synthetic polymers, when extrapolated to zero concentration, yield a rough value of the true molecular weight. (3) New techniques for rapid attainment of sedimentation equilibrium make equilibrium ultracentrifugation a practical method for molecular weight determinations. (4) The magnetically suspended ultracentrifuge has inherent characteristics much more suitable for low speed centrifuging than presently available commercial centrifuges. (A.G.W.)

20135 AN OBSERVATION PORT IN A WALL SHIELDING RADIO-ACTIVE RADIATION. (to European Atomic Energy Community). British Patent 921,884. Mar. 27, 1963. Priority date Mar. 2, 1961, Belgium.

An observation port using a mirror optical system is designed which facilitates exchange of the mirrors during observation. The port comprises a casing with two diametrically opposed windows (one at each side of the wall), an obstruction spaced between the two windows to provide two bent light paths therebetween, and mirrors on the obstruction and on the interior of the casing. The obstruction preferably forms a diamond-shaped figure. (D.L.C.)

20136 IMPROVEMENTS IN OR RELATING TO JOINTS OR FASTENINGS BETWEEN TENSIONED PLATES OR MEMBRANES. Alan Henry Butler (to General Electric Co. Ltd.). British Patent 922,068. Mar. 27, 1963. Filed Feb. 1, 1961.

A joint between tensioned plates or membranes is designed which is applicable to the fabrication of pressure vessels. The joint comprises a pair of abutting flanges secured together by bolts which pass between the abutting flange faces at the line of intersection of the faces with the neutral surface of the flanges, i.e., the bolts are not subjected to induced bending stresses. The bolts are inserted into projections in the flanges which are inclined at an angle of 30° to the neutral surface. (D.L.C.)

20137 IMPROVEMENTS RELATING TO GRIPPING DEVICES. Arthur Michael Smith (to United Kingdom Atomic Energy Authority). British Patent 922,968. Filed Nov. 30, 1960.

A remotely operated grab is designed for grasping articles through narrow openings, such as in a reactor core. The grab comprises two interfitting relatively rotatable tubes, adjacent corresponding ends, internal jaw plates with eccentric apertures, and means for rotating the tubes in order to vary the overlapping of the apertures for closing the jaw plates around an article to be grasped. (D.L.C.)

20138 IMPROVEMENTS IN METHODS AND APPARATUS FOR MANUFACTURE OF POROUS DIAPHRAGMS. Jacques Maire, Michel Germain Rio, and Pierre Schaegis (to Commissariat a l'Energie Atomique). British Patent 923,504. Apr. 10, 1963. Priority date Sept. 18, 1958, France.

A method is given for the continuous manufacture of porous diaphragms comprising metal gauzes coated with polytetrafluoroethylene, which are especially suited for isotopic separation by gaseous diffusion. The method comprises diffusing an impregnating agent into a polytetrafluoroethylene powder, depositing the impregnated powder on an intermediate support, removing the excess of agent by rolling against an absorbent material, transferring the deposit to a metal gauze by rolling between cylinders, and washing the coated gauze to remove the rest of the agent. A roller apparatus for carrying out the method is described. (D.L.C.)

20139 IMPROVEMENTS IN OR RELATING TO TELEVISION CAMERA ARRANGEMENTS. Donald Jackson (to Pye Ltd.). British Patent 923,815. Apr. 18, 1963. Filed Oct. 30, 1958.

A television camera unit is designed for use in a reactor or a radioactive environment. The unit has a housing which is adapted for connection with a tubular holder. Cooling gas may be passed into the housing to protect the camera from high temperatures. (D.L.C.)

20140 TUBE OR HOSE CONSTRUCTION. Donald Jackson (to Pye Ltd.). British Patent 923,816. Apr. 18, 1963. Filed Oct. 12, 1959.

A flexible tube or hose is designed for supplying cooling air to a television camera in a high-temperature zone and for suspending the camera in the zone such as in a reactor core. The hose comprises a central tube for carrying the air flow to the camera and being surrounded by a plurality of smaller, helically wound tubes for return flow and/or for feeding gas under pressure to operate controls on the camera. The electric cable connecting the camera to the control unit preferably extends through the inner tube. The hose may be used with the camera cooling arrangement described in British Patent 923,817. (D.L.C.)

20141 IMPROVEMENTS IN AND RELATING TO TELEVISION CAMERAS. Donald Jackson (to Pye Ltd.). British Patent 923, 817. Apr. 18, 1963. Filed Oct. 12, 1959.

A housing assembly is designed for maintaining a television camera at a desired working temperature while being operated in a zone of high ambient temperature,

e.g., in a reactor. The housing comprises a plurality of coaxial tubular elements forming a number of annular chambers around the camera. Each element has openings connecting adjacent chambers together for circulation of cooling gas from the inner chamber toward the outer chamber. The cooling gas may be fed to the housing by a hose described in British Patent 923,816. (D.L.C.)

20142 IMPROVEMENTS IN OR RELATING TO TELEVISION CAMERAS. Donald Jackson (to Pye Ltd.). British Patent 923,818. Apr. 18, 1963. Filed Oct. 30, 1958.

The television camera equipment is designed for use in high-temperature environments, such as in a reactor core. In the equipment, the camera is contained within a housing which is connected to a hose for supplying a cooling gas to the camera during its operation. The hose is described in more detail by British Patent 923,816. (D.L.C.)

20143 DEVICE FOR PROTECTION AGAINST NEUTRON OR OTHER PENETRATING RADIATION. Jaroslav Kholl. Czechoslovak Patent 98,898. Mar. 15, 1961.

Collapsible containers with a renewable filler are suggested for protection against neutron or other radiation. As to its structure, the filler is a space lattice into which rods, disks, and other standard-shaped parts of a radiation-absorbing material are mounted. The remaining gaps are filled with water or other liquid medium used as moderator. (OTS)

20144 PROCESS AND DEVICE FOR CONVEYING A LOAD BETWEEN TWO FLUID CONTAINING RESERVOIRS. (to Bureau d'Études Nucléaires). French Patent 1,276,293. Oct. 9, 1961. Priority date Jan. 5, 1960, Belgium.

In nuclear power plants it is often necessary to convey a load, e.g., a fuel element from one fluid containing reservoir to another. According to this patent the load passes through a relatively narrow transfer tube connecting the said two reservoirs and being supported by a carriage shaped like a cradle and provided at both extremities with pistons having a diameter slightly smaller than the inner tube diameter, this support is adapted to move by the difference of the pressures created within said transfer-tube at both sides of the support respectively. The inside of the transfer tube may be separated from the two reservoirs by valves through which the support may enter into troughs situated in these reservoirs and forming extensions of said transfer tube. (IIB)

20145 VALVED DUCTING. Gordon Brown (to United Kingdom Atomic Energy Authority). U. S. Patent 3,082,821. Mar. 26, 1963. Priority date Sept. 10, 1958, Great Britain.

A coaxial ducting for fluid flow between a heat source and a heat exchanger is designed with a single valve of the sleeve type for controlling fluid flow in both the inner and outer ducts. Two embodiments of the valve are described, one adapted for push-pull operation and the other for rotary operation. (D.L.C.)

20146 TRANSPIRATION COOLED SOOT BLOWER. Curtis C. Beausman (to United Nuclear Corp.). U. S. Patent 3,084,373. Apr. 9, 1963. Filed Mar. 29, 1960.

A soot blower for removing soot accumulations is designed for permanent installation in steam superheaters. The soot blower comprises a core including a pressure fluid conduit, a plurality of nozzles, and an air cooling system. The cooling system comprises a gas-permeable sheath disposed about the conduit and having apertures for the ejection of pressure fluid by the nozzles to outside the sheath, and means for conducting coolant to the interior of the sheath. (D.L.C.)

Heat Transfer and Fluid Flow

Refer also to abstracts 20597, 21219, 21252, 21253, and 21345.

20147 (AD-282370) INVESTIGATION OF LIQUID METAL BOILING HEAT TRANSFER. Quarterly Progress Report No. 3. Richard E. Balzhiser, C. Phillip Colver, S. M. Kim, William A. Myers, Herman Merte, Jr., Andrew Padilla, Jr., Conrad S. Revak, and Lowell R. Smith (Michigan. Univ., Ann Arbor. Coll. of Engineering). July 1962. Contract AF33(616)-8277. 29p. (ORA-04526-5-P)

Design of the experimental apparatus was completed and construction initiated in several programs. Potassium will be boiled from the outside of a $\frac{3}{8}$-in. OD Haynes-25 tube at temperatures up to 2000°F and heat fluxes of 10^6 Btu/hr ft^2. Equipment is under construction. Film-boiling studies employing potassium as the test fluid and sodium as the heating fluid will be conducted. Boiling will occur from a 0.200-inch Nb-1% Zr disk in a 1-inch Nb-1% Zr tube. A forced-circulation liquid metal loop is being constructed. The facility will circulate potassium at liquid flow rates up to 2 gpm. The maximum fluid temperature in the loop will be 1800°F. Potassium will be preheated to various qualities using clamshell heaters. Condensing sodium is used to boil the potassium in the test section. Fluxes of up to 10^6 Btu/hr ft^2 are anticipated. Two phase flow studies will be conducted as a part of the forced circulation investigation. Pressure drop and void fraction measurements will be made for different qualities and flow rates. This equipment is being assembled and tested. Loop instrumentation will be used in conjunction with the pool boiling studies. Agravic studies with mercury are scheduled. Studies will be from 1 to 20 g's with the liquid level varied to insure uniform pressures at liquid-vapor and liquid-solid interfaces. (auth)

20148 (BNL-756) PROCEEDINGS OF 1962 HIGH-TEMPERATURE LIQUID-METAL HEAT TRANSFER TECHNOLOGY MEETING, BROOKHAVEN NATIONAL LABORATORY, MAY 17-18, 1962. (Brookhaven National Lab., Upton, N. Y.). Contract [AT(30-2)-Gen-16]. 404p. (BNL-C-35)

Proceedings of the Second Annual High-Temperature Liquid-Metal Heat Transfer Technology Meeting are presented, except for 2 classified papers. Separate abstracts were prepared for 22 of the remaining 24 papers. Two were previously abstracted for NSA. (M.C.G.)

20149 (BNL-756(p.1-18)) DEVELOPMENT PROBLEMS OF SNAP REACTOR SYSTEMS. G. Montgomery Anderson (Division of Reactor Development, AEC).

Materials problems in the SNAP systems imposed by the launch and space environments that are accentuated by a requirement to push to higher temperature levels and endurance than can be met by some of the more conventional materials are discussed. Three SNAP systems, 10A 2, and 8, are considered. One basic objective of the SNAP reactors is that the N_H (number of hydrogen atoms/cc $\times$ 10^{-22}) must be maximized to achieve a minimum system weight. It is shown that fuel stability at elevated temperatures forces a compromise between allowable N_H and maximum reactor operating temperature. Problems with system actuators, motors, wiring, and electronic components that must operate in a radiation field under vacuum at elevated temperatures are described. (M.C.G.)

20150 (BNL-756(p.19-39)) ALKALI METAL PHYSICAL PROPERTIES PROGRAM AT PRATT & WHITNEY

AIRCRAFT-CANEL. R. E. Cleary and S. M. Kapelner (Pratt and Whitney Aircraft Div., United Aircraft Corp. Connecticut Aircraft Nuclear Engine Lab., Middletown).

Progress in the program to extend the physical property data of alkali liquid metals in the high-temperature region is reported. The electrical resistance of the liquid alkali metals was measured in parallel with a type 347 stainless steel container. With the exception of lithium, the resistivity was proportional to atomic number throughout the temperature range. The thermal conductivity of lithium was found to increase with temperature while for the other alkali metals it decreased with temperature. The solubility of helium in lithium between 650 and 870°C was determined. Equipment for determining liquid-metal viscosity, wetting characteristics, vapor pressure, and vapor density is being developed. (M.C.G.)

20151 (BNL-756(p.64-76)) THE ENGINEERING PROPERTIES OF POTASSIUM. Joseph F. Walling (Battelle Memorial Inst., Columbus, Ohio).

Equipment and methods are being developed to determine the following properties of potassium: vapor pressure; specific heat of the liquid; thermal conductivity of the liquid; viscosity of the vapor; viscosity of the liquid; vapor compressibility; and specific heat of the vapor. Data on vapor pressure, heat content, and viscosity are presented in graph form. (M.C.G.)

20152 (BNL-756(p.77-96)) RUBIDIUM–CESIUM EVALUATION PROGRAM. THERMODYNAMIC PROPERTY MEASUREMENTS. D. L. Cochran (Aerojet-General Nucleonics, San Ramon, Calif.).

Thermodynamic property measurements on Rb and Cs are summarized. Density of saturated liquid between the melting temperature and 1350°F and vapor pressure between 1000 and 1800°F are presented for both Rb and Cs. Additional work in process and planned is also described. (auth)

20153 (BNL-756(p.97-113)) SUMMARY OF SODIUM BOILING AND CONDENSING STUDIES. R. C. Noyes (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The completed experiments on boiling and condensing demonstrate that, as expected, heat transfer coefficients for nucleate boiling and condensing of sodium are extremely high. Heat transfer behavior in these systems was shown to be generally similar to nonmetal systems. The burnout heat flux measurements confirmed the dominant influence of hydrodynamic parameters, but also showed an important influence of liquid transport properties. Experience with construction and operation of the simple geometry pool boiling and condensing experiments proved invaluable in developing experimental equipment and techniques for the more complicated forced-convection boiling studies. (auth)

20154 (BNL-756(p.114-25)) LIQUID METAL BOILING STUDIES. Richard E. Balzhiser (Michigan. Univ., Ann Arbor).

Methods for studying nucleate pool boiling, film boiling, and two-phase fluid dynamics and heat transfer of potassium are discussed. Equipment designs are described. The equipment developed to study nucleate boiling and natural convection heat transfer in mercury at accelerations ranging from 1 to 20 times that of normal gravity is also described. (M.C.G.)

20155 (BNL-756(p.126-30)) POOL BOILING OF SODIUM. Max W. Carbon (Wisconsin. Univ., Madison).

Studies under way to obtain heat transfer data on pool boiling of sodium are described. The test section consists basically of two right-angle cylinders. One cylinder contains a pool of liquid sodium and a horizontal, cantilever-type heating element. The other cylinder contains a water-cooled condenser and a cartridge-type heater that serves as a preheater. Successful preliminary experiments were carried out. (M.C.G.)

20156 (BNL-756(p.131-54)) ALKALI METALS BOILING AND CONDENSING INVESTIGATIONS. R. D. Brooks (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati).

Preliminary results were obtained for forced convection for boiling and condensing in single tubes with potassium. Pool boiling data were also obtained. Three forced convection experiments were put into operation with heat transfer capabilities from 50 to 300 kw at the test sections. A 1600°F stainless steel system was operated to provide condensing data and instrumentation development. Over 2000 hours of operation were accumulated for heat transfer purposes. A 300 kw test, constructed of L-605, was operated at temperatures up to 1850°F and accumulated over 700 hours of operation for heat transfer data purposes. Boiling and condensing data were obtained in this test as well as liquid phase heat transfer coefficients for sodium in an annulus. The 100 kw test, constructed of Nb–1Zr, was put into operation and will be operated at temperatures up to 2200°F. The characteristics of the experimental systems are described and the data reviewed. (auth)

20157 (BNL-756(p.155-80)) LIQUID METAL HEAT TRANSFER TEST PROGRAMS. James J. Killackey (AiResearch Mfg. Co. Div. of Garrett Corp., Phoenix, Ariz.).

Results of experimental programs are reported. Data are presented for forced-convection boiling of potassium at temperatures up to 1480°F. Stable flow boiling without evidence of exceeding the critical heat flux was obtained at a heat flux of 320,000 Btu per hr ft^2 at a 15% average vapor quality. A description of lithium hydride handling procedures that were developed as part of the experimental evaluation of a solar heat receiver are described. (auth)

20158 (BNL-756(p.182-203)) FORCED-CONVECTION SATURATION BOILING OF POTASSIUM AT NEAR-ATMOSPHERIC PRESSURE. H. W. Hoffman and A. I. Krakoviak (Oak Ridge National Lab., Tenn.).

Heat transfer and fluid mechanics of potassium are being studied. The general details of the ORNL boiling-potassium loop are described. Experiments thus far were directed toward accumulation of data on the critical heat flux for forced-convection saturation boiling of potassium, with information on two-phase pressure losses and heat-transfer coefficients being a secondary goal. The desired data were obtained by maintaining the heat flux at the boiling interface at some fixed value while decreasing the flow in a stepwise pattern until burnout occurred. Average heat-transfer coefficients were calculated by combining the heat flux as determined from the enthalpy change of the fluid with the temperature difference defined by the inside-wall temperature and the inlet and exit fluid temperature. Results are presented in tabular form. (M.C.G.)

20159 (BNL-756(p.219-27)) RUBIDIUM–CESIUM EVALUATION PROGRAM. HEAT TRANSFER AND FLUID FLOW STUDIES. C. R. Fisher (Aerojet-General Nucleonics, San Ramon, Calif.).

Progress in the study of boiling heat transfer and fluid

flow characteristics of cesium and rubidium in forced convection is reported. Loop design and data reduction methods are described. (M.C.G.)

20160 (BNL-756(p.228-35)) HIGH TEMPERATURE BOILING MERCURY EXPERIMENT. C. J. Baroczy (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

In order to provide a sound experimental and analytical basis for the design of mercury boilers, an apparatus is being designed to experimentally determine the heat transfer characteristics of pool boiling and forced convection boiling of mercury. With the objective of achieving high boiling heat fluxes (on the order of 1×10^6 Btu/hr/ft^2) at high temperature levels (1000 to 1400°F) the effects of wetting agents, corrosion inhibitors, swirl devices, and materials will be investigated. The proposed design of the electrically heated test sections is described. (auth)

20161 (BNL-756(p.236-61)) POTASSIUM–MERCURY AMALGAM HEAT TRANSFER AND TWO PHASE FLOW INVESTIGATION. C. R. Smith, Y. S. Tang, and P. T. Ross (General Motors Corp. Allison Div., Indianapolis).

Progress on potassium-mercury amalgam heat transfer and two-phase flow investigation is reported. Designs of experimental equipment and instrumentation are described. Facility check-out was made with pure mercury and preliminary results on boiling and forced-convection heat transfer data with mercury are given. Void fraction determinations on two-phase metallic fluids were examined and results are compared with reported values in the literature. Subsequent modifications and initial operations of potassium-mercury amalgams are also discussed. Future work planned for this project is outlined. (auth)

20162 (BNL-756(p.262-75)) LIQUID METAL RESEARCH AT NASA-LEWIS RESEARCH CENTER. James P. Lewis (National Aeronautics and Space Administration. Lewis Research Center, Cleveland).

Liquid-metal research activities are summarized with emphasis on the heat transfer aspects of these studies. A two-phase flow loop, constructed of stainless steel, is being operated with sodium. A sodium turbine facility, pump test facilities, liquid alkali metal heat transfer facility, space radiator and condenser facility, and equipment for bearing and seal studies are being constructed. Experiments are being planned to study the flow and heat transfer processes in a typical SNAP-8 radiator tube. Materials support programs are discussed. (M.C.G.)

20163 (BNL-756(p.276-85)) EXPERIMENTAL DETERMINATION OF OVERALL HEAT TRANSFER COEFFICIENTS FOR CONDENSING SODIUM (1140 TO 1840°F). J. A. Roth (Aeronautical Systems Div., Wright-Patterson AFB, Ohio).

The results of work in the initial phases of a multiphase program on condensation with alkali metals are presented. The first prototype boiler unit was designed to operate at temperatures to 1600°F and pressures of 0.1 mm Hg to 50 psig. The boiler was operated continuously with a liquid sodium charge for 136.5 hr at temperatures above 1100°F. The maximum temperature reached was 1830°F. The run was terminated when a fire developed where some sodium vapor leaked through the window seal and condensed on the screw heads of the window clamp ring. Two additional prototype boilers were constructed and operated. The first was used to obtain heat transfer data on sodium and the second for rubidium. Based on experimental findings, it was concluded that the classical Nusselt equation does not adequately describe alkali metal condensation. (M.C.G.)

20164 (BNL-756(p.286-91)) RUBIDIUM HEAT TRANSFER TESTING AT SUNDSTRAND AVIATION-DENVER. R. Loehrke (Sundstrand Aviation-Denver, Pacoima, Calif.).

A test loop is in operation to obtain order of magnitude information concerning the heat transfer rate during the boiling of rubidium in a small-diameter tube with the net production of dry vapor. The apparatus consists of two storage tanks on either side of the test strip, a stainless steel tube of 0.125 in. ID, 0.065-in. wall thickness, and 33 in. long. The test strip surface temperature measurements were made with calibrated chromel-alumel thermocouples and the saturation temperature of the rubidium was determined from a pressure measurement obtained at the exit of the test strip. High heat transfer coefficients during boiling of rubidium up to a quality of approximately 70% are shown. Preliminary data were obtained in a rubidium condensing loop. (M.C.G.)

20165 (BNL-756(p.292-3)) BOILING AND CONDENSING LIQUID METAL LOOP. D. V. Foster (Westinghouse Electric Corp. Astronuclear Lab., Pittsburgh).

A liquid-metal loop designed to provide data on boiling and condensing heat transfer coefficients, vapor pressure, latent heat of vaporization, and corrosive effects is described. (M.C.G.)

20166 (BNL-756(p.294-325)) DEVELOPMENT OF SNAP 2 HEAT TRANSFER COMPONENTS. W. D. Leonard and R. D. Keen (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.).

The development of 6 SNAP 2 heat transfer components is described. These are the expansion compensator, the parasitic load heater, the flow trimmer, the orbital start pump, the radiator-condenser, and the auxiliary ground heater. Results of system tests are discussed. (M.C.G.)

20167 (BNL-756(p.326-52)) DESIGN AND FABRICATION OF A 2100°F FORCED CONVECTION LITHIUM TEST LOOP. Ivan L. Gray (Martin-Marietta Corp. Aerospace Div., Baltimore).

Progress is reported on the design, fabrication, and installation of a one-inch diameter, niobium alloy, forced convection loop that is rated at a temperature of 2100°F and flow of 20 gpm lithium. The overall system is briefly described and emphasis is placed on the resolution of problems that arose during the design and fabrication stages. Photographs taken during the loop assembly are presented. (auth)

20168 (BNL-756(p.353-79)) GEOSCIENCE LTD. PROGRESS REPORT ON HIGH-TEMPERATURE LIQUID-METAL HEAT TRANSFER FOR THE AEC. H. F. Poppendiek and N. D. Greene (Geoscience Ltd., Solana Beach, Calif.).

Results are presented of a review and summary of past liquid metal heat and momentum transfer research; analytical two-phase flow, heat transfer and thermodynamic properties studies; preliminary mercury heat transfer system design studies; and experimental two-phase flow momentum transfer studies. The past research which was studied consisted of non-boiling heat and momentum transfer and film and nucleate pool boiling. The analytical work included separated two-phase flows, vortex decay, free-convection film boiling, forced-convection film boiling, Mollier diagrams and physical properties. Experimental two-phase flow pressure drop data on air-water flows in a helical passage were obtained and compared with predicted values. (auth)

20169 (BNL-756(p.380-5)) BOILING SODIUM EXPERIMENTAL STUDIES. J. B. Heineman and J. F. Marchaterre (Argonne National Lab., Ill.).

Experiments are being developed to observe the behavior of a forced-convection, two-phase sodium loop to obtain data on boiling heat transfer and frictional pressure drop and to simulate the operation of a higher pressure sodium vapor cycle at temperatures up to 2100°F. Progress was concentrated on the development of reliable instrumentation. (M.C.G.)

20170 (BNL-756(p.386-98)) EDDY DIFFUSIVITY EFFECT IN LIQUID-METAL HEAT TRANSFER. O. E. Dwyer (Brookhaven National Lab., Upton, N. Y.).

A method for evaluating ψ, which is defined as the ratio of ϵ_H/ϵ_M, in equations for calculating heat transfer coefficients of liquid metals flowing turbulently through regular shaped conduits is described. Examples are given for flow in circular pipes, flow in concentric annuli, and inline flow through rod bundles. (M.C.G.)

20171 (LADC-4844) STEADY-STATE TEMPERATURE SOLUTION FOR A HEAT-GENERATING CIRCULAR CYLINDER COOLED BY A RING OF HOLES. J. C. Rowley and J. B. Payne (Los Alamos Scientific Lab., N. Mex.). [196?]. Contract [W-7405-eng-36]. 50p.

A series solution is presented to the heat-conduction equation for a heat-generating circular cylinder pierced axially by a ring of equal holes spaced uniformly on a concentric circle. The solution is based upon a class of potential functions previously defined by Howland. Nondimensional curves for peak and average temperatures and optimum location of the ring of holes for uniform convective cooling are presented. In addition, some shape factors or conductances for the geometry are given. (auth)

20172 (NP-12699) INVESTIGATION OF LIQUID METAL BOILING HEAT TRANSFER. Quarterly Progress Report No. 4. Richard E. Balzhiser, Robert E. Barry, C. Phillip Colver, Herman Merte, Jr., Andrew Padilla, Jr., and Lowell R. Smith (Michigan. Univ., Ann Arbor. Coll. of Engineering). Feb. 1963. Contract AF33(616)-8277. 64p. (ORA-04526-14-P)

The high-flux nucleate pool boiler was subjected to preliminary check-out procedures during which water was pool boiled at fluxes from 20,000 to 500,000 Btu/(hr)(sq ft). The results checked well with previous data from a $^3/_8$-in.-OD tube. Thermocouple failures in the boiling tube produced a temporary delay. Construction of the film boiler was essentially completed. The liquid metal loop was received. Installation procedures were almost completed. The agravic studies were set back by a series of delays in the design and construction stages. Analytical studies of the film-boiling process have progressed. Preliminary results from this study are discussed, and calculated minimum fluxes for several alkali metals are tabulated. (auth)

20173 (PWAC-213) SUMMARY REPORT OF SINGLE-TUBE BRANCH AND MULTI-TUBE BRANCH WATER FLOW TESTS CONDUCTED BY THE UNIVERSITY OF CONNECTICUT. M. H. Zeisser (Connecticut. Univ., Storrs). [nd]. For Pratt and Whitney Aircraft Div., United Aircraft Corp., Middletown, Conn.). Contract AT (11-1)-229. 46p.

Results of studies on liquid pressure loss and flow distribution through radiators are presented. A series of tests, using water as the test liquid, investigated turning pressure losses both into and out of single 90° branch connections and the effect of the branching and collecting flows on the fluid stream in the header and collector. The effect of joint intersection geometry was also investigated. Three multiple-tube header and collector units were tested to determine pressure losses and flow distribution. (auth)

20174 (TID-17707) HIGH ACCELERATION FIELD HEAT TRANSFER FOR AUXILIARY SPACE NUCLEAR POWER SYSTEMS. Quarterly Technical Report, September 1 to November 30, 1962. H. F. Poppendiek, N. D. Greene, F. R. MacDonald, and H. R. Wright (Geoscience Ltd., San Diego, Calif.). Contract AT(04-3)-409. 42p. (GLR-11).

A detailed description is presented of the completed design for the experimental boiling and condensing liquid-metal heat transfer system. The experiments can be conducted with either mercury or potassium. Photographs and drawings show the important system components (preheater, boiler, condenser, subcooler, storage tanks, separator, instrumentation systems, etc.). A discussion is given of high temperature containment and material compatibilities problems in addition to the estimation of argon solubility in liquid metals. The results of some mercury safeguard studies are summarized. Several analytical heat and momentum transfer studies were conducted. One investigation describes simultaneous heat transfer and fluid flow under zero gravity, forced flow film boiling or condensation in a tube. Other studies define the velocity decay of thin, rotating liquid layers in stationary tubes whose walls are separated from the liquid layers by a thin, viscous gas film. These solutions can be used to predict heat transfer and fluid flow in high vapor quality boiling and condensing Rankine cycle space power plants. (auth)

20175 INTERACTION OF MAGNETOHYDRODYNAMIC SIMPLE WAVES IN MONATOMIC FLUIDS. Roy M. Gundersen (Illinois Inst. of Tech., Chicago). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 711-12(Mar. 1963).

It is shown that the interaction of hydromagnetic simple waves may be reduced to a single second-order, linear, partial differential equation, and the Riemann function thereof may be found from a Fourier superposition of the solutions of a linear, second-order, ordinary differential equation. (C.E.S.)

20176 A SIMILAR SOLUTION OF THE TURBULENT, FREE-CONVECTION, BOUNDARY LAYER PROBLEM FOR AN ELECTRICALLY CONDUCTING FLUID IN THE PRESENCE OF A MAGNETIC FIELD. Yoram Hopenfeld (Atomics International, Canoga Park, Calif.) and Reno R. Cole. AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 718-19 (Mar. 1963).

Equations are developed for the care of turbulent flow, and the results are compared with results previously obtained for the care of laminar flow. (D.E.B.)

20177 HEAT TRANSFER BIBLIOGRAPHY—RUSSIAN WORKS. A. V. Luikov (Inst. of Energetics, Minsk). Intern. J. Heat Mass Transfer, 6: 309-23(Apr. 1963).

References (336) are given to books and journals published during 1961 and 1962. The references cite information on general and mass heat transfer problems, phase conversion, chemical conversions and combustion, drying processes, building materials and construction, nuclear reactors, and thermophysical properties. (P.C.H.)

20178 GENERALIZATION OF EXPERIMENTAL DATA ON HEAT TRANSFER WITH NUCLEATE BOILING ON THE BASIS OF THE THEORY OF THERMODYNAMIC SIMILARITY. V. M. Borishanskii and A. P. Kozyrev. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 5: No. 12, 3-8(Dec. 1962). (In Russian)

The method for the generalization of heat transfer with

nucleate boiling is developed on the basis of the theory of thermodynamic similarity. Semiempirical formulas including critical pressure and temperature parameters, molecular weight, effective saturation pressure, and heat load are obtained. On the basis of these data, the heat transfer coefficient calculated is within ±30% of that confirmed by experimental results. (auth)

20179 RESEARCH ON THE EFFECT OF CHANNEL DIAMETER ON THE SIZE OF THE CRITICAL THERMAL LOAD FOR BOILING WATER. R. A. Rybin. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 2, 15-19(Feb. 1963). (In Russian)

The effect of channel diameter on heat load at the transition from nucleate boiling to film boiling is studied. Experiments were carried out on a loop with forced circulation. During the experiments weight flow changed from 17,000 to 70,000 neutrons · m^{-2} · sec^{-1}, vapor-content at the exit varied up to 10 per cent, channel diameter was varied from 2 to 10 mm; and pressure was maintained at 101.3×10^5 neutrons · m^{-2}. The relative length of the pipes was l/d = 40. The channel diameter was found to essentially influence the critical load. An empirical formula is obtained that allows an estimation of the effect of the channel diameter on the critical heat load over the range of parameters investigated. (auth)

20180 A SOLUTION FOR THREE-DIMENSIONAL VORTEX FLOWS WITH STRONG CIRCULATION. W. S. Lewellen (Aerospace Corp., Los Angeles). J. Fluid Mech., 14: 420-32(1962).

The Navier-Stokes equations for a viscous, incompressible fluid are considered for a steady, axisymmetric flow composed of a strong rotation combined with radial sink flow which exhausts axially inside a finite radius. The equations are reduced to two coupled partial differential equations in terms of the stream function and circulation. The equations contain three dimensionless parameters: the radial Reynolds number, a characteristic ratio of mass flow per unit length to circulation, and a characteristic ratio of an axial dimension to a radial dimension. The product of these last two dimensionless parameters is used as a new expansion parameter for generating an asymptotic series solution. To zeroth order in this parameter, the solution for the stream function is a linear distribution between two axial boundary values. First-order correction terms are calculated for a specific example. In discussing these equations the limitations of the exact solutions due to Donaldson & Sullivan (1960) and Long (1961) are noted. These exact solutions are contrasted with the approximate treatment of this type of vortex originated by Einstein & Li (1951) and generalized by Deissler & Perlmutter (1958). (auth)

20181 MAGNETOHYDRODYNAMIC WAKES. M. B. Glauert (Univ. of Manchester, Eng.). J. Fluid Mechan., 15: 1-12(Jan. 1963).

The most notable feature of magnetohydrodynamic flow at large distances from a three-dimensional body is the formation of two wakes, within which vorticity and electric current are confined. Results are obtained for the effective diffusivity and the relation between current and vorticity in each wake, for the balance between the strengths of the disturbances in the wakes and in the irrotational current-free flow outside, and for the lift and drag forces acting on the body. The final answers take the form of remarkably simple extensions of the corresponding formulas for non-conducting flow. In spite of the extra wake and the presence of a magnetic as well as a velocity field, the flow perturbation at large distances still has only three degrees of freedom. (auth)

20182 ON THE HYDRODYNAMIC EQUATIONS FOR FLOW OF LIQUID HELIUM II WITH MUTUAL FRICTION. A. A. Townsend (Emmanuel Coll., Cambridge, Eng.). J. Fluid Mechan., 15: 262-72(Feb. 1963).

The flow of liquid helium II at subcritical velocities can be described by hydrodynamic equations that assume the possibility of independent motions of the two fluid components, but difficulties arise in supercritical flows with forces of mutual friction between the component fluids. The extensive evidence that mutual friction is caused by scattering of the thermal excitations in the velocity fields of the quantized vortex lines suggests that the equations should include mutual forces that are large near the vortex-lines and negligible elsewhere. In their original theory, Hall & Vinen did assume this; the implications of the assumption are examined in detail. Serious difficulties are found in reconciling localization of the mutual friction with fully developed flow in channels, and it is suggested that, although the mutual friction arises from scattering near the vortex lines, the force on the superfluid is distributed uniformly over distances comparable with the distance between adjacent vortex lines. (auth)

20183 ON THE NON-LINEAR ENERGY TRANSFER IN A GRAVITY WAVE SPECTRUM. PART 2. CONSERVATION THEOREMS; WAVE-PARTICLE ANALOGY; IRREVERSIBILITY. K. Hasselmann (Univ. of California, La Jolla). J. Fluid Mechan., 15: 273-81(Feb. 1963).

From the conditions of energy and momentum conservation all four interaction coefficients of the elementary quadruple interactions discussed in the previous paper are shown to be equal. A further conservative quantity is then found that can be interpreted as the number density of the gravity-wave ensemble representing the random sea surface. The well-known analogy between a random linear wave field and a mass particle ensemble is found to hold also in the case of weak non-linear interactions in the wave field. The interaction conditions for energy transfer between waves to correspond to the equations of energy and momentum conservation for a particle collision, the final equation for the rate of change of the wave spectrum corresponding to Boltzmann's equation for the rate of change of the number density of an ensemble of colliding mass particles. The stationary wave spectrum corresponding to the Maxwell distribution for a mass particle ensemble is found to be degenerate. The question of the irreversibility of the transfer process for gravity waves is discussed but not completely resolved. (auth)

20184 ON THE NON-LINEAR ENERGY TRANSFER IN A GRAVITY-WAVE SPECTRUM. PART 3. EVALUATION OF THE ENERGY FLUX AND SWELL-SEA INTERACTION FOR A NEUMANN SPECTRUM. K. Hasselmann (Univ. of California, La Jolla). J. Fluid Mechan., 15: 385-98(Mar. 1963).

The energy transfer due to non-linear interactions between the components of a gravity-wave spectrum discussed in preceding parts of this paper is evaluated for a fully and partially developed Neumann spectrum with various spreading factors. The characteristic time scales of the energy transfer are found to be typically of the order of a few hours. In all cases the high frequencies and low-frequency peak are found to gain energy from an intermediate range of frequencies. The transfer of energy to very low frequencies and to waves travelling at large angles to the main propagation direction of the spectrum is neg-

ligible. Computations are presented also for the rate of decay of swell interacting with local wind-generated seas (represented by a Newmann spectrum). An appreciable decay is found only for swell frequencies in the same range as those of the local sea. (auth)

20185 THE EFFECT OF A STRONG MAGNETIC FIELD ON TWO-DIMENSIONAL FLOWS OF A CONDUCTING FLUID. Stephen Childress (California Inst. of Tech., Pasadena). J. Fluid Mechan., 15: 429-41(Mar. 1963).

The motion of a viscous, electrically conducting fluid past a finite two-dimensional obstacle is investigated. The magnetic field is assumed to be uniform and parallel to the velocity at infinity. By means of a perturbation technique, approximations valid for large values of the Hartmann number M are derived. It is found that, over any finite region, the flow field is characterized by the presence of shear layers fore and aft of the body. The limit attained over the exterior region represents the two-dimensional counterpart of the axially symmetric solution given by Chester. Attention is focused on a number of nominally "higher-order" effects, including the presence of two distinct boundary layers. The results hold only when $M \gg$ the Reynolds number. However, a generalization of the procedure, in which the last assumption is relaxed, is suggested. (auth)

20186 MAGNETOHYDRODYNAMIC WAVES IN ROTATING LIQUIDS. S. D. Nigam and P. D. Nigam (Indian Inst. of Tech., Kharagpur). Proc. Roy. Soc. (London), Ser. A, 272: 529-41(Apr. 9, 1963).

The directional distribution and attenuation of waves created by a harmonically oscillating point source placed at the axis OX of an incompressible, inviscid, unbounded, electrically conducting liquid was studied by using a technique developed by Lighthill. The undisturbed motion of the liquid consists of a rigid rotation Ω about OX and a uniform velocity of translation U along OX in the presence of a uniform external magnetic field H_0 along OX. The effect of U is to make wave propagation asymmetrical with respect to x. The rotation causes radial expansion of the Alfvén waves and the magnetic field produces a radial contraction of the Taylor waves. The interaction of U, Ω, H_0, and ω is the main theme. A novel feature of the interaction is the splitting of Taylor waves by the magnetic field. (auth)

20187 ON RESONANCES IN FORCED OSCILLATIONS OF INCOMPRESSIBLE CONDUCTING LIQUID IN TRANSVERSE MAGNETIC FIELD. I. B. Chekmarev (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 32: 1477-9(Dec. 1962). (In Russian)

It is shown that resonance effects are possible in a conducting liquid with forced oscillations in a transverse magnetic field. (R.V.J.)

20188 HEAT EXCHANGER AND BOILER, PARTICULARLY ADAPTED TO USE THE HEAT GIVEN OFF BY NUCLEAR REACTORS. Georges Trepaud. British Patent 923,509. Apr. 10, 1963. Priority date Jan. 14, 1959, France.

A heat exchanger and a boiler are designed for heat transfer between a first fluid under a low pressure and a second fluid under a very high pressure. The boiler comprises a plurality of straight parallel tubes arranged in an annular nest, and two annular distribution chambers of ring construction for distribution of high-pressure fluid to and from the tubes. A device for detecting leakages is described. (D.L.C.)

Materials Testing

20189 (ANL-6630) LAMB WAVES: THEIR USE IN NONDESTRUCTIVE TESTING. Roberta Ann di Novi (Argonne National Lab., Ill.). Mar. 1963. Contract W-31-109-eng-38. 20p.

A series of experiments is described which is primarily concerned with establishing the usefulness of Lamb waves for the detection of small defects in thin plates and in small-diameter, thin-walled tubing. Results indicate that Lamb waves offer greater sensitivity and resolution than do the more conventional nondestructive test methods such as shear waves. (J.R.D.)

20190 IMPROVEMENTS RELATING TO NUCLEAR REACTORS AND IMPROVEMENTS IN TESTING MEANS. John Roger Scrivener Kistruck and John David Dell (to Babcock and Wilcox Ltd.). British Patent 922,339. Mar. 27, 1963. Filed Feb. 3, 1960.

A device is designed for subjecting a length of test material to a stress within a reactor pressure vessel containing fluid at superatmospheric pressure. The device includes a bellows closed at one end to a closure member secured rigidly to one end of the test length and means for holding the other end at a fixed distance from the other end of the test length. The test length is provided with marks for measuring the amount of creep. (D.L.C.)

GEOLOGY, MINERALOGY, AND METEOROLOGY

20191 (AHSB(RP)-R-27) THE BIOLOGICAL AND GEOGRAPHICAL DISTRIBUTION IN THE IRISH SEA OF RADIOACTIVE EFFLUENT FROM WINDSCALE WORKS 1959 TO 1960. J. Mauchline (United Kingdom Atomic Energy Authority. Production Group, Windscale, Sellafield, England). Jan. 1963. 74p.

Investigations to determine the fate of the radioactive effluent which is discharged from Windscale Works into the northeastern Irish Sea were made. The ash contents of 17 species of seaweeds and 67 species of invertebrates common in the sea area were determined. Levels of radioactivity originating from K^{40} and other naturally occurring radioisotopes were investigated and are discussed. A few measurements of nuclides in the sea areas distant from Sellafield were made to assess the contribution to the Irish Sea of nuclides from fallout sources. The levels of β-activity in the samples of marine organisms decreased by a factor of 20 in the first 20 miles of distance north or south from Sellafield. No significant build-up of effluent material has taken place in the vicinity of Sellafield during the past 7 years, nor is there evidence of a build-up in any other area. No organisms were found to concentrate fission products by factors greater than those previously known. Typical concentration factors for ruthenium, cerium, and zirconium in seaweeds and invertebrates were of the order of 1000. Values for cesium were about 100 and for strontium less than 40. For fish, the concentration factors tended to be somewhat lower, especially for ruthenium and strontium. Marked differences were found between species and this enables a number of species to be selected for possible use as biological indicators. Of the seaweeds, Laminaria spp; Corallina officinalis, and Ceramium rubrum are suitable. Among the animals the most convenient are the polychaete worms, Balanus porcatus (barnacle), Littorina littorea (winkle), and Crangon vulgaris (shrimp). (auth)

20192 (CEA-2219) ESSAIS DE PROSPECTION GÉOCHIMIQUE DE L'URANIUM EN PAYS ARIDE. (Experiments on Geochemical Prospection for Uranium in Arid Country). A. Grimbert and J. M. Obellianne (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Fontenay-aux-Roses). 1962. 48p.

The necessity for preliminary inquiries before applying routine geochemical prospecting techniques to the exploration of a new region is shown. Under conditions presumed to be unfavorable for geochemical prospecting as found in Nigeria along the banks of the Aïr, a preliminary examination showed that sampling of the stabilized superficial deposits at a depth of 15 cm made it possible to detect the presence of U-containing mineralizations hidden under about 20 meters of sterile sandy deposits. To confirm this result, a boring located on a U-containing geochemical anomaly in a paleosol, encountered a mineralized formation at a depth of 28 meters. (auth)

20193 (HW-70892) DUAL ATMOSPHERIC TRACER TECHNIQUES FOR DIFFUSION STUDIES USING PHOSPHORESCENCE-FLUORESCENCE ANALYSIS. J. D. Lucwick (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1961. Contract AT(45-1)-1350. 17p.

The feasibility of using fluorescein simultaneously with ZnS as tracers in atmospheric dispersion and transport studies was studied. The results were used to develop an analytical technique for wind studies to determine the effects of release height on ground-level dosage pattern. (J.R.D.)

20194 (LA-2808) FAST ELECTROMAGNETIC SIGNALS PRODUCED BY NUCLEAR EXPLOSIONS IN THE TROPOSPHERE. J. Karl Theobald (Los Alamos Scientific Lab., N. Mex.). Nov. 1962. Contract W-7405-eng-36. 17p.

Observations during the Pacific tests in the summer of 1962 by the author and others confirm the presence of high-frequency components of the electromagnetic signal which vary in polarity according to the eastern or western location of the recording station from the detonation point. The interaction of relativistic Compton electrons produced by the gamma rays from the detonation with the geomagnetic field is discussed and shown to be capable of producing the signals observed. (auth)

20195 (NP-12678) SEISMOLOGY TODAY. THE PROCEEDINGS OF A COLLOQUIUM HELD IN CAMBRIDGE, DECEMBER 13th–15th, 1960. (United Kingdom Atomic Energy Authority. Field Experiments Div., Blacknest, Berks, England). July 1961. 29p.

Aspects of seismology are examined in terms of developing means for differentiating between natural occurrences and underground explosions. Topics discussed are detection problems, Project Vela, studies of the outer mantle, data handling and processing, British earthquakes, explosion seismology, body waves in the earth, surface waves and free oscillations, investigation of focal mechanism by first motion data, coupling of explosions to the ground, decoupled explosions, model studies, seismometer arrays and boreholes, microseisms, wide-band seismographs, and observatory seismology. 35 references. (D.C.W.)

20196 (NP-12700) CHARACTERISTIC EMISSIONS FROM AN UNDERGROUND EXPLOSION. Second Semi-Annual Report. Dean Reily and Vincent Cushing (Engineering Physics Co., Rockville, Md.). Dec. 3, 1962. Contract DA-49-146-XZ-089. 68p.

The wave shapes of seismic disturbances resulting from underground nuclear explosions are investigated. Wave propagation near the explosion where the soil is subject to high compressive forces is discussed; and the results are presented as particle displacement and velocity vs time, shock front arrival time, and peak particle velocity vs radial distance from the explosion. Results of an analysis of the transition of the disturbance to seismic waves are expressed in terms of particle acceleration, displacement, and velocity vs time. The elastic precursor that propagates ahead of the main disturbance if the disturbance propagates subsonically is examined, and wave forms that might be received at a hypothetical gage station are given. Derivation of the equation of state and other details of wave propagation from information on the precursor is also discussed. Secondary wave generation from spall impact is additionally considered. Recommendations for a more accurate analysis of the phenomena involved are included. (D.C.W.)

20197 (TID-18456) GEOLOGIC ASPECTS OF THORIUM RECOVERY FROM COMMON ROCKS. Quarterly Progress Report, December 1, 1962–February 28, 1963. John A. S. Adams and John J. W. Rogers (Rice Univ.,

Houston, Tex.). For Oak Ridge National Lab., Tenn. Contract [W-7405-eng-26], Subcontract 1491. 11p.

Effort during the report period was devoted to various laboratory studies on a 1700-ft sample of Conway granite core. The incomplete autoradiographic and alpha pulse-height analyses of the whole core were delayed by the large computing time required for the experimental data and the large instrumental time needed. Results of theoretical studies on Th, including those concerning U. S. placer sands are included. Autoradiographs were developed for Core "C" thin sections of granite. Total alpha spectra from Core "C" thorite, huttonite, and zircon are presented. The spectra show that the thorite and huttonite activities are caused almost entirely by the Th series, while the zircon spectrum has large U-series contributions. (J.R.D.)

20198 (TID-18502) FEASIBILITY OF CREATING SPHERICAL CAVITIES IN UNDERGROUND SALT DOMES. Progress Report, February and March 1963. (Texas. Univ., Austin). Contract AT(29-2)-1051. 40p.

Tests in which the inert blanket space vs. height curve was followed to successful completion of a spherical shape were carried out to obtain reproducible results in large salt blocks from the Grand Saline mine. The tests were programed to wash 2-ft spheres inside 4 blocks of salt measuring ~4 ft × 4 ft × 4½ ft. One cavity failed after 20 hr of washing when 30% complete, another after 4 hr at 18%, and the third after 30 hr at 45%. In the other block one complete 12-in. sphere and one partial 12-in. sphere were obtained. Effects of angle, the influence of a stratified fluid, surface irregularities, velocity profiles, and cavity closure tests are discussed. (M.C.G.)

20199 (FTD-TT-62-269) METHODS FOR A DETAILED STUDY OF SEISMICITY. V. I. Bunz, M. V. Gzovskii, et al. Translated from Tr. Inst. Fiz. Zemli, Akad. Nauk SSSR, No. 9, (1960). 551p. (AD-400507)

Apparatus used for seismic observations is described, and methods for interpreting seismic data are discussed. Determination of earthquake foci and the structure of the earth's crust from earthquake data receives particular attention. Seismic energy determination and the dependence of the main earthquake oscillation frequencies on seismic energy are examined. Results of application of the techniques in two regions of Russia are given. 283 references. (D.C.W.)

20200 ON THE RADIOACTIVITY OF ITALIAN THERMAL SPRINGS. Marino Pacelli. Ann. Med. Navale (Rome), 67: 109-12(Jan.-Feb. 1962).

20201 METEOROLOGY AND MONITORING OF RADIATIONS IN THE FREE ATMOSPHERE IN THE VICINITY OF A NUCLEAR SITE. A. Doury. Bull. Inform. Sci. Tech. (Paris), No. 64, 46-63(Aug.-Sept. 1962). (In French)

The problem of monitoring radiations in the atmosphere in the vicinity of nuclear sites is essentially a question of detecting and measuring pollution by turbulent diffusion of gas and fine aerosols. A simple mathematical solution to this problem, still approximate but usable, is proposed and sufficiently confirmed by a number of actual size experiments and model experiments. The solution requires rapid and accurate knowledge of a certain number of meteorological parameters (winds and vertical temperature gradients) with some complementary general information on atmospheric situations and developments. Radioactivity monitoring itself and verification of pollution forecasts consist of permanent or occasional atmospheric sampling. Correct interpretation of sampling and monitoring results is not possible without the concomitant meteorological parameters. (auth)

20202 ARTIFICIAL RADIOACTIVITY OF THE AIR, RESULTS ACQUIRED IN 1961. J.-Cl. Philippot. Bull. Inform. Sci. Tech. (Paris), No. 64, 64-72(Aug.-Sept. 1962). (In French)

The results of beta measurement of the air at ground level and high altitude are reported. New techniques are described. The passage of aerosols resulting from the French atomic explosions and new contamination from the resumption of Soviet tests are illustrated by equal activity curves. Some observations on measurements made by aircraft are made. (auth)

20203 CHEMICAL SEPARATIONS OF LONG-LIVED RADIOISOTOPES PRESENT IN THE ATMOSPHERE: Ce^{144}, Cs^{137}, Zr^{95}, Sr^{90}, AND Ru^{106}. G. Hémon. Bull. Inform. Sci. Tech. (Paris), No. 64, 73-8(Aug.-Sept. 1962). (In French)

A method for the separation of fission products in air and rain water is described. A tracer determination was made of the efficiencies and the contamination of various fractions. The method requires the use of non-radioactive carriers. It separates the radioisotopes with good efficiency (better than 90%) and satisfactory purity (contamination <1%). Samplings of atmospheric dusts or rain water are put in hydrochloric acid solution. After introduction of the carriers, a separation into groups is made. Each group is purified in order to obtain the radioisotope sought. The elimination of some interfering ions is described. In the case of recent fission products, the various fractions separated may contain several radioisotopes; processes for the estimation of each are mentioned or suggested. (auth)

20204 A STUDY OF AURORAL ABSORPTION AT 30 MC/S. T. R. Hartz, L. E. Montbriand, and E. L. Vogan (Defence Research Telecommunications Establishment, Ottawa). Can. J. Phys., 41: 581-95(Apr. 1963).

The occurrence of auroral absorption, as observed over a two-year period at six Canadian stations extending in a north-south line between Resolute Bay and Ottawa, is discussed. On the average, the zone of maximum occurrence of auroral absorption is located near 63° geomagnetic latitude but tends to shift several degrees farther south during periods of strong magnetic activity. The occurrence falls off rapidly to the north of the zone maximum, and there is no indication of an inner zone of auroral absorption activity. Contour plots are used to illustrate occurrence as a function of geomagnetic latitude and mean geomagnetic time. The resulting pattern shows a principal maximum near 0800 hours and a secondary maximum an hour or two before geomagnetic midnight. The pattern appears to fit the theoretical model of high-latitude disturbances as developed by Axford and Hines, and the possibility is discussed that there are two distinct phases in this disturbance pattern that correspond to the two diurnal maxima in the auroral absorption data. (auth)

20205 OBTAINING STABLE ISOTOPES OF LEAD Pb^{206} AND Pb^{208}. E. S. Burkser and G. D. Eliseeva (Geological Inst., Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 1, 82-4(1963). (In Ukrainian)

A description is given of the methods of extracting isotopes, enriched in Pb^{206} and Pb^{208}, from radioactive minerals. The isotopes were then used as standards for determining lead in minerals by the method of isotope dilution for establishing the absolute age of the minerals. (auth)

20206 ORIGIN OF THE ZIRCON IN METASOMATIC MODIFIED BASIC ROCKS. G. K. Eremenko and A. A. Valter (Inst. of Mineral Resources, Academy of Sciences,

Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 1, 92-4(1963). (In Ukrainian)

The probable causes of the origin of zircon in the process of replacement of gabbro-pyroxenite by albite-lepidomelane metasomatic rock were analyzed. The replacement was accompanied with the addition of alkalis, fixing of fluorine in lepidomelane (1.5 pC), and with loss of Ca and Mg. It was concluded that the fluorine complex form of zirconium transport in the postmagmatic solution and the formation of zircon as a result of decay of the fluorine complexes was the diminution of the fluorine concentration and changing of the concentration and composition of the cations in the solution. (auth)

20207 THE GENERATION AND EFFECT OF ELECTROSTATIC FIELDS DURING AN AURORAL DISTURBANCE. Daniel W. Swift (Avco Corp., Wilmington, Mass.). J. Geophys. Res., 68: 2131-40(Apr. 15, 1963).

The equations of motion of electrons and ions in the presence of electric, magnetic, and neutral particle velocity fields are derived for conditions likely to exist in an auroral arc. The electric field resulting from charge separation is computed. Electron densities, charged-particle motion, and electric currents are also computed. It is shown how these computations can account for magnetic bays, electron drifts, and electric field fluctuation observed during auroral disturbances. Analytical expressions for electric field strengths and neutral plasma drift velocities are derived. (auth)

20208 THEORY OF AURORAL ELECTROJETS. J. A. Fejer (Southwest Center for Advanced Studies, Dallas). J. Geophys. Res., 68: 2147-57(Apr. 15, 1963).

Two mechanisms are described for the formation of electrojet currents in the auroral zone. Both mechanisms require the existence of magnetospheric convection in which only particles of relatively low energy participate. It is essential to both mechanisms that particles of one sign (positively or negatively charged) should predominate among the energetic ones that do not participate in the convection of the magnetosphere. In the first mechanism the convection of the magnetosphere is taken to be of tidal origin, driven by the electric polarization fields associated with the dynamo current systems. In the second mechanism the convection is assumed to be the corotation of the magnetosphere with the earth, as modified by the solar wind that distorts the geomagnetic field. In both mechanisms the ionospheric currents are a consequence of the relative motion between the less energetic particles that almost fully participate in magnetospheric convection and the more energetic particles whose adiabatic drift motion across the magnetic field is only slightly perturbed by the electric fields associated with the convection of the magnetosphere. If the particles that do not participate are assumed to be the trapped energetic protons observed by Explorer 12 during magnetically quiet days, either mechanism predicts variations of the order of ±50 γ in the horizontal component of the geomagnetic field at auroral latitudes. (auth)

20209 THE EFFECTS OF NUCLEAR BURSTS IN SPACE ON THE PROPAGATION OF HIGH-FREQUENCY RADIO WAVES BETWEEN SEPARATED EARTH TERMINALS. C. M. Crain and H. G. Booker (Rand Corp., Santa Monica, Calif.). J. Geophys. Res., 68: 2159-66(Apr. 15, 1963).

A possible method for detecting nuclear bursts in space is discussed. The method is based on the effects that the bursts should have on the phase and amplitude of high-frequency radio transmission between separated terminals on the earth's surface. Relations are derived that show how these effects should vary with time after the nuclear detonation and how they are related to bomb temperature, yield, and distance from the earth. The phase shift is independent of bomb temperature over a wide range of temperatures, whereas attenuation decreases by a factor of about 10 (in decibels) for each 50 per cent decrease in bomb temperature. Thus, absorption-measuring techniques become decreasingly attractive for detecting cooler bombs. It is concluded that measurements of high-frequency phase and amplitude change, in conjunction with very-low-frequency phase measurements, may provide a very sensitive means for detecting nuclear bursts in space by ground-based radio equipment, even for quite cool bombs. The possibility of determining bomb temperature is also shown. (auth)

20210 AN ESTIMATE OF THE ISOTOPIC COMPOSITION OF STRONTIUM IN ROCKS OF THE PRECAMBRIAN SHIELD OF NORTH AMERICA. G. Faure, P. M. Hurley, and H. W. Fairbairn (Massachusetts Inst. of Tech., Cambridge). J. Geophys. Res., 68: 2323-9(Apr. 15, 1963).

An examination of the Sr extracted from the calcareous shells of fresh-water mollusks from localities on the Precambrian shield of North America has revealed significant enrichment of Sr^{87} relative to primary basalt Sr. This enrichment was predicted on the basis of the average Rb/Sr ratio and estimated age of the crystalline basement rocks. The average Sr^{87}/Sr^{86} ratio for the calcareous shells, grouped according to the geologic age province in which they were found, are as follows: Kenoran age province (2.5 b.y), 0.721 ± 0.005; Hudsonian age province (1.7 b.y.), 0.720 ± 0.002; and Grenville age province (1.0 b.y.), 0.717 ± 0.004. The isotopic composition of Sr in calcareous shells from the Great Lakes and the general drainage system of the St. Lawrence River seems to be in reasonable correlation with the bedrock geology of the drainage basin. No evidence of fractionation of Sr isotopes during incorporation in the calcareous shells was found. (auth)

20211 SURVEY OF Rb^{85}/Rb^{87} RATIOS IN MINERALS. W. R. Shields (National Bureau of Standards, Washington, D. C.), E. L. Garner, C. E. Hedge, and S. S. Goldich. J. Geophys. Res., 68: 2331-4(Apr. 15, 1963).

The Rb^{85}/Rb^{87} abundance ratio for a reference sample of rubidium sulfate was determined as 2.5995 ± 0.0015 (95 per cent confidence interval) on a mass spectrometer with a 12-inch radius of curvature and a triple-filament mode of ionization. The abundance ratio was measured for 27 natural silicate samples that represent a wide geographic distribution. Isotopic ages for these samples range from 20 m.y. to 2600 m.y., and a variety of minerals and geologic origins are represented. No variations in the atomic abundance ratio of Rb^{85}/Rb^{87} larger than that accounted for by experimental error were observed. The absolute ratio remains to be determined. (auth)

20212 GEOMAGNETIC AND SOLAR DATA. J. Virginia Lincoln ed. (National Bureau of Standards, Boulder, Colo.). J. Geophys. Res., 68: 2335-41(Apr. 15, 1963).

Some geomagnetic and solar data for the second half of 1962 are presented. Times of sudden commencements followed by geomagnetic disturbances, of sudden pulses found in magnetograms, and of solar-flare effects are given. Principal magnetic storm data also include the storm time, type, activity, amplitude, range, and maximal activity on the K-scale. Other data include the K_p, C_i, C_p, A_p, K_{Fr}, and R_i, and selected days for geomagnetic and solar events in December 1962. Planetary magnetic three-hour-range indices are also included. (D.C.W.)

20213 LOCAL TIME DEPENDENCE OF THE MAGNITUDE OF GEOMAGNETIC-STORM SUDDEN COMMENCEMENTS. A. J. Shirgaokar and H. Maeda (Kyoto Univ.). J. Geophys. Res., 68: 2344-7(Apr. 15, 1963).

Dependence of the magnitude of geomagnetic-storm sudden commencements on local time was studied by examining IGC and IGY data taken by pairs of stations at about the same geomagnetic latitude, but with one station in darkness and the other in sunlight. Local noon is favored for maximum magnitudes for stations near the geomagnetic equator, but a shift to later hours is noted for increases in geomagnetic latitude. For stations near the auroral zone, a shift in the opposite direction occurs. (D.C.W.)

20214 TIME SCALES OF ISOSTATIC COMPENSATIONS. H. Takeuchi (Tokyo Univ.). J. Geophys. Res., 68: 2357(Apr. 15, 1963).

Retardation of isostatic compensations by a kind of flow process within the earth is examined. A flow process by which the relaxation time of the Fennoscandian uplift is proportional to the square of the characteristic wavelength rather than the inverse wavelength is discussed. This process involves an intermediate layer in which viscous flows take place and gives more acceptable results. The intermediate layer is calculated as 400 km. (D.C.W.)

20215 DETECTION OF FRESH FISSION PRODUCTS IN SYDNEY FROM THE 1962 CHRISTMAS ISLAND NUCLEAR TEST SERIES. D. R. Davy and R. M. Green (Australian Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Nature, 198: 77(Apr. 6, 1963).

Fission products arising from the American nuclear weapons test series at Christmas Island between April 25 and July 11, 1962, were detected in Sydney, Australia, in both air and rain water within a period of 3 weeks. A histogram of the specific activities of fission products showed a marked peak for all isotopes over the sampling period July 10 to 21, 1962, at which time an intense anticyclone passed over Sydney. Minor peaks were also observed under similar meteorological conditions. Correlation of fallout levels with height and duration of inversion layers associated with these meteorological conditions is discussed. (C.H.)

20216 MEASUREMENTS OF RADIOACTIVITY IN AUSTRIAN WATERS. A. Frantz. Oesterr. Wasserwirtsch., 13: 45-9(1961).

Details are given of the method used for the determination and calculation of radioactivity in surface waters of Austria, and results are given of determinations in 1960 at 15 places that were chosen as being of importance for water supply. Determinations were made monthly, except in the Danube where they were fortnightly. With one exception the measured radioactivities were not much above the limit of sensitivity of the apparatus used and were similar to those found in surface waters of Germany and Switzerland. The exception was Lake Neusiedler, which has a relatively high content of potassium and showed considerably increased potassium and total activity, exceeding the permissible limit for water supply of 10 $\mu\mu c/l$ for an unknown mixture of activities. Lake Neusiedler is not used for water supply, and further examination showed that alpha activity and the dangerous Sr^{90} and Cs^{137} were present in amounts well below the permissible limits. Tests of plankton, water plants, small organisms, flesh and bones of fish, and sludge gave results similar to those in other Austrian waters, and no accumulation of radioisotopes could be found. (Public Health Eng. Abstr. 43: No. 4, April 1963)

20217 TWO-STREAM PLASMA INSTABILITY AS A SOURCE OF IRREGULARITIES IN THE IONOSPHERE. D. T. Farley, Jr. (National Bureau of Standards, Boulder, Colo.). Phys. Rev. Letters, 10: 279-82(Apr. 1, 1963).

An extension of the theory of the two-stream plasma ion wave instability and an application of the theory to the physics of the ionosphere are discussed. The effect of a magnetic field and also the effect of collisions with neutral particles are included in the theory. Qualitative and quantitative predictions of the theory are in agreement with the observed characteristics of an irregularity found in the equatorial ionosphere. Similar irregularities often appear in the polar ionosphere during auroral displays and are perhaps caused by two-stream instability. (C.E.S.)

20218 THE STRUCTURE OF THE IONIZED GAS ENVELOPE OF EARTH FROM DIRECT MEASUREMENTS IN THE U.S.S.R. OF LOCAL CHARGED PARTICLE CONCENTRATIONS. K. I. Gringauz. Planetary Space Sci., 11: 281-96(Mar. 1963). (Translated by O. M. Blunn from Iskusst. Sputniki Zemli, No. 12, p.105, 1962).

Measurements consisting of a number of determinations of the concentrations of electrons and ions in the outer ionosphere above the maximum of ionization of the F region are presented. The approximate altitude distribution of the charged particles in the ionized gas envelope of Earth is plotted, the boundary of this envelope is determined, and conclusions regarding the boundary variability at different altitudes are outlined. (C.E.S.)

20219 ANALYSIS OF RESULTS OF SIMULTANEOUS MEASUREMENTS OF ELECTRON CONCENTRATION IN THE IONOSPHERE BY IONOSPHERE STATIONS AND ROCKETS. K. I. Gringauz and G. L. Gdalevich. Planetary Space Sci., 11: 321-6(Mar. 1963). (Translated by H. S. H. Massey from Iskusst. Sputniki Zemli, No. 13, p.89, (1962).

Calculated height-frequency curves are compared with actual characteristic curves obtained at an ionosphere station in the neighborhood of the rocket's firing point. It is shown that the calculated curves are close to the actual curves and, in particular, have the same height breaks. The closeness of the height-frequency curves obtained from rocket measurements of the electron concentration distribution to height-frequency curves obtained by ionospheric sounding from the earth confirms the reliability of the rocket measurements and the correctness of the conclusions that the region of the ionosphere at altitudes of 100-300 km is a medium with a steady rise in the electron concentration and does not break down into separate layers. (C.E.S.)

20220 LOW LATITUDE FIELD ALIGNED IONIZATION OBSERVED BY THE ALOUETTE TOPSIDE SOUNDER. G. E. K. Lockwood and L. E. Petrie (Defence Research Telecommunications Establishment, Ottawa). Planetary Space Sci., 11: 327-30(Mar. 1963).

Unusual features are observed in ionograms recorded at low latitudes. Radio waves are reflected from an overdense region of ionization that lies along a magnetic field line. The variation in height of the irregularities as a function of latitude is depicted. The range of the echoes reflected by the irregularities has a well-defined maximum. (C.E.S.)

20221 FURTHER ANALOGUE STUDIES OF THE IONOSPHERIC F LAYER. H. Rishbeth (Radio Research Station, Slough, Bucks, Eng.). Proc. Phys. Soc. (London), 81: 65-77(Jan. 1, 1963).

The analogue computer described by Briggs and Rishbeth in 1961 is used to solve the continuity equation for electron

density in the F region of the ionosphere, taking account of production, loss and vertical diffusion of ionization. Two atmospheric models are used, one with complete mixing of the neutral constituents and one with diffusive separation; for each of these, experiments are made with large, small and zero coefficients of plasma diffusion. Studies of the diurnally varying electron distributions show that, just after sunrise, the increase of electron density is controlled mainly by photo-ionization. By mid-day, the layer approaches an equilibrium condition in which the height of the peak is controlled by diffusion and loss. In the models with zero diffusion coefficients, a peak of electron density is formed temporarily after sunrise but does not exist, at a finite height, at other times of the day or night. After sunset, diffusion and loss act in such a way as to establish a stationary layer that preserves its shape while it decays at a uniform rate. A possible equilibrium of the night F layer, maintained by downward flow of ionization from the exosphere, is also considered. A special study is made of the way in which the F layer responds to diurnal and eclipse variations in the ionizing radiation. At any height below the F2 peak, the behavior of the layer is mainly determined by the local values of the production and loss rates; but in the upper part of the F layer, vertical coupling by diffusion is so strong that the variations of electron density closely follow those at the F2 peak and are independent of local rates of production or loss, or even of diffusion. In a further experiment, an attempt is made to simulate the nonlinear loss process operative in the lower F region, and the resulting splitting of the layer into F1 and F2 components is demonstrated. (auth)

20222 MAGNETIC FIELD MEASUREMENTS IN SPACE. Laurence J. Cahill, Jr. (Univ. of New Hampshire, Durham). Space Sci. Revs., 1: 399-414 (Mar. 1963). (In English)

A brief account of the general conception of the outer geomagnetic field and of the interplanetary magnetic field at the beginning of the present period of satellite magnetometer investigations is given. An objective account of the important findings of each of the satellite magnetometer experiments is presented. An interpretation of the effects of these findings on the present status of the conception of the outer geomagnetic field, the boundary region, and interplanetary magnetic field is discussed. A brief review of satellite magnetometers is also given. (C.E.S.)

20223 URANIUM MINING CHEMISTRY. Ch'eng-chi Kuo. Peking, Ch'u Pan She, 1956. 139p. Available from Library of Congress, Washington, D. C. (In Chinese)

The geochemistry of U is discussed and the various kinds of deposits are described. Special attention is given to the physical and chemical characteristics of U ores as well as the analytical methods applicable to U. The chemical composition of U was investigated, and the criteria required for U prospecting are considered. (TCO)

20224 PORTATIVNYE GENERATORY NEITRONOV V YADERNOI GEOFIZIKE. (Portable Neutron Generators in Nuclear Geophysics). S. I. Savosin. Moscow, Gosatomizdat, 1962. 204p.

Ten Russian and ten translated American articles are included on construction and application of neutron generators in geophysics. The theory of pulsed neutron-neutron well logging and practical applications of generators in certain oil deposits in USSR are discussed. Various neutron generating tubes, design and construction of field logging equipment, and in neutron generator applications (producing short-life isotopes, activation analysis, reactor construction and mining industries) are also discussed. (R.V.J.)

20225 PRIKLADNAYA YADERNAYA GEOFIZIKA. (Applied Nuclear Geophysics). L. S. Polak, ed. Moscow, Publishing House of the Academy of Sciences, 1962. 580p.

Applications of nuclear sources in geology and geophysics are surveyed. Principles of nuclear physics, nuclear radiation sources, radiation reactions with substances, natural radioactivity of rocks, and nuclear reactions in nature are discussed in the first chapter. Radiation detection and recording methods and equipment are covered in the second chapter while laboratory and field methods are covered in the third and fourth chapters. Gamma-gamma, neutron-neutron, and neutron-gamma logging and isotope methods are surveyed in the fifth chapter. The sixth chapter is devoted to problem modeling using the principle of similarity and the seventh to safety measures and techniques. Supplemental tables of (γ,n) and $(n,2n)$ reactions, inelastic neutron scattering, $(n,p)(n,\alpha)$ and (n,γ) reactions, and lists of various types of photomultipliers and integrating and dosimetric equipment are included. (R.V.J.)

20226 STRONTIUM SORPTION STUDIES ON CRANDALLITE. Geological Survey Bulletin 1144-C. Irving May, Marian M. Schnepfe, and Charles R. Naeser (Geological Survey, Washington, D. C.). 1963. 29p. (TEI-819)

Crandallite ores may be useful in the treatment of nuclear-waste solutions because of their reactivity with strontium in weakly acid solutions and in alkaline solutions containing aluminum. The exchange capacity of the crandallite sample studied is not very high, being 6 to 10 milliequivalents of strontium and 2 milliequivalents of cesium per 100 grams of active phosphatic material. However, strontium removal is many times more effective in alkaline solutions, with precipitation being the dominant mechanism. The removal of strontium is even more complete in alkaline solutions containing aluminate ions. (auth)

20227 BIOGEOCHEMISTRY OF SULFUR ISOTOPES. Proceedings of a National Science Foundation Symposium held at Yale University, April 12-14, 1962. Mead LeRoy Jensen, ed. New Haven, Yale University, 1962. 203p.

Sixteen papers are presented on the biological, chemical, bacteriological, and geological properties of sulfur, with the emphasis on the variations of stable sulfur isotopes. Separate abstracts were prepared for 8 of the papers; one of the remaining papers was previously abstracted in NSA. (D.L.C.)

20228 BIOGENIC SULFUR AND SULFIDE DEPOSITS. Mead LeRoy Jensen (Yale Univ., New Haven). p.1-15 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

The possibility of using sulfur isotopic studies to determine whether sulfur has been derived from an inorganic or biogenic source was investigated. The results of experiments on anaerobic bacteria are described. Sulfur isotopic measurements on magmatic hydrothermal deposits, native sulfur deposits, uranium deposits, copper deposits, and pyrites are discussed. It is concluded that sulfur isotopic studies alone will not provide an answer to the genesis of the deposits. (D.L.C.)

20229 SUMMARY OF SULFUR ISOTOPIC STANDARDS. Wayne U. Ault (Hawaiian Volcano Observatory, Hawaii National Park) and M. L. Jensen. p.16-29 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

A review is presented of the primary standards which have been used for sulfur isotopic analyses. Tables are presented of the primary standards and of the S^{32}/S^{34} ratios for seawater sulfate. The conclusions of a committee from the symposium are outlined. It was agreed to adopt Cañon Diablo troilite sulfur as the basic primary standard, with an arbitrary S^{32}/S^{34} ratio of 22.220 for which $\delta S^{34} = 0$. (D.L.C.)

20230 SULFUR ISOTOPE METEORITE STANDARDS RESULTS AND RECOMMENDATIONS. M. L. Jensen and N. Nakai (Yale Univ., New Haven). p.30-5 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

Several meteorites from the Yale collection were analyzed for their S^{32}/S^{34} ratio by three different chemical techniques. The results show a remarkable similarity of the δS^{34} composition of sulfide sulfur in meteorites. Possible errors in the chemical techniques are discussed. The quality and choice of standards are discussed. (D.L.C.)

20231 NEW ZEALAND SULFUR STANDARDS IN RELATION TO METEORITIC SULFUR. J. R. Hulston (McMaster Univ., Hamilton, Ont.). p.36-41 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

The discrepancies between the New Zealand sulfur isotopic standards and these used elsewhere are discussed. The standards were recalibrated on the basis of the Cañon Diablo troilite, and they agree better with these of the Lamont and Yale groups. The conversion of δS^{34} values for sea water and Merck working standards to δS^{34} values for Cañon Diablo meteoritic standard is discussed. (D.L.C.)

20232 SULFUR ISOTOPE MEASUREMENTS ON NEW ZEALAND, AUSTRALIAN, AND PACIFIC ISLANDS SPECIMENS. T. A. Rafter (Inst. of Nuclear Sciences, Lower Hutt, N. A.). p.42-60 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

Geochemical results are reported on sulfur isotope ratios measured on geothermal bore waters, volcanic sulfur, coal, ore minerals, and other geological samples. (D.L.C.)

20233 SOME NECESSARY CONDITIONS FOR FRACTIONATION OF STABLE ISOTOPES OF SULFUR BY DESULFOVIBRIO DESULFURICANS. Galen E. Jones and Robert L. Starkey (Rutgers Univ., New Brunswick, N. J.). p.61-79 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

Studies were made on the fractionation of S^{32} and S^{34} during the reduction of sulfate to sulfide by D. desulfuricans and during the oxidation of elemental sulfur to sulfate by T. thiooxidans. Fractionation was observed for D. desulfuricans only for high concentrations of sulfate. No fractionation was observed during oxidation by T. thiooxidans. (D.L.C.)

20234 THE MICROBIOLOGICAL FRACTIONATION OF SULFUR ISOTOPES. I. R. Kaplan and S. C. Rittenberg (Univ. of Southern California, Los Angeles). p.80-93 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

A number of studies on the bio-fractionation of sulfur isotopes are described. Among the organisms studied are D. desulfuricans, E. coli, S. cerevisiae (yeast), P. vulgaris, T. concretivorus, and Chromatium. A study of sulfur compounds in Southern California marine sediments indicates that sulfate reduction is the most important reaction in the sulfur cycle. (D.L.C.)

20235 STABLE CARBON ISOTOPES OF THE GAS HILLS URANIUM DISTRICT, WYOMING. Eric S. Cheney (Yale Univ., New Haven). p.179-93 of "Biogeochemistry of Sulfur Isotopes." New Haven, Yale University, 1962.

The possible origins of Gas Hills District uranium deposits are described. In order to determine the origin, carbon isotopic analyses were carried out on ~70 carbonate samples. The permil values of epigenetic carbonates were too variable to be attributed to the dissolution and reprecipitation of fresh water or marine carbonate strata. The results indicate that the carbonates precipitated contemporaneously with uranium mineralization are of biogenic origin and that the anaerobes responsible for uranium mineralization used woody material as a source of energy. (D.L.C.)

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Refer also to abstracts 19746 and 20216.

20236 (AD-282023) APPLICATION OF WEATHER RADAR TO FALLOUT PREDICTION. Quarterly Technical Report No. 16, December 1, 1961 through February 28, 1962. Pauline M. Austin (Massachusetts Inst. of Tech., Cambridge. Dept. of Meteorology). Mar. 15, 1962. Contract DA 36-039 SC-75030. 10p.

During the quarter intensity contour data from several long storms containing widespread light rain or snow were added to the backlog of quantitative data on winter storms. In instrumentation work progress was made on devices for quantizing the output from the delay-line integrator and for displaying several intensity levels simultaneously. It is expected that they will be completed during the coming quarter. An F-M sweep integrator for use with short pulse on the AN/CPS-9 radar is also progressing well and should be in operation some time during the summer. In addition, an RHI for the SCR-615-B radar is under construction. Investigations of measurement of rainfall over an area are continuing. Excellent results are obtained at close ranges, but in certain types of storms at ranges beyond 40 miles, effects related to the filling of the beam and the height of the radar horizon above the ground become apparent. An observational program designed to study the extent and seriousness of these problems was set up. In the consideration of modification of fallout patterns by rain computations concerning the dispersion of the radioactive cloud from a 10kt detonation have been completed for a selected wind field, one in which the wind speeds involved are of average magnitude. Computations are now underway for a situation in which the winds are unusually light. (auth)

20237 (CEA-2250) DOSIMETRIE DES NEUTRONS RAPIDES EN VUE DE LA RADIOPROTECTION AUPRES DES GRANDS ACCELERATEURS. APPLICATION AU SYNCHROTRON A PROTONS SATURNE. (Fast Neutron Dosimetry for Radioprotection Near Large Accelerators. Application to the Proton Synchrotron Saturne). Philippe Tardy-Joubert (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 45p.

Methods are described that are used for the measurement of a neutron flux, and of the corresponding energy flux and dose absorbed. The methods are checked experimentally by the use of neutron sources of known energy distribution. The conditions of use of a proportional counter for recoil protons are described. The experimental results obtained with the synchrotron SATURNE at Saclay are described. (auth)

20238 (COO-274) FIRE TESTS OF SHIPPING CONTAINERS AND COBALT-60 TELETHERAPY HEAD. Leonard H. Horn (Underwriters' Labs., Inc., Chicago). Mar. 31, 1963. Contract AT(11-1)-1022. 77p.

Fire tests of several isotope shipping containers and a cobalt-60 teletherapy head were conducted under controlled conditions equivalent to similar tests conducted upon record protection equipment such as safes and filing cabinets. Fire test exposures were limited to 1 hr maximum time and test furnaces were controlled to produce interior temperatures in accordance with the Standard Time-Temperature Curve adopted by United States Fire Protection authorities, also as set forth in proposed Part 72 of Federal Regulations. The lead-shielded devices failed to comply with the proposed Regulation because of melting of the lead shielding, rupture of the steel body shells enclosing and supporting the shielding material and consequent loss of the shielding media. The all-steel shipping container, which can be used for the shipment of liquids, failed by destruction of the sealing gaskets. (auth)

20239 (DPSPU 63-30-10) RADIUM CONTENT OF DRINKING WATER IN THE CENTRAL SAVANNAH RIVER AREA. W. F. Edgar (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Apr. 1963. Contract AT(07-2)-1. 8p.

Samples of water from wells in the vicinity of the Savannah River Plant were collected during 1961 and 1962 and analyzed for naturally occurring isotopes of Ra. The total Ra in drinking water ranged from less than 0.3 to 9 pc/l. (C.H.)

20240 (HMI-B21) DIE NATÜRLICHE RADIOAKTIVITÄT DER ATMOSPHÄRE UND IHRE BEDEUTUNG FÜR DIE STRAHLENBELASTUNG DES MENCHEN. (The Natural Radioactivity of the Atmosphere and its Significance for the Radiation Protection of Man). W. Jacobi (Hahn-Meitner-Institut für Kernforschung, Berlin). Mar. 1962. 296p.

The behavior and distribution of radon, thorium, and their decay products in the atmosphere are considered. A related description of the cycle of natural radioactivity in the atmosphere is given. The inhalation of natural radionuclides is discussed, and the resulting radiation burden to man is estimated. Topics covered include: radionuclides of the radon and thorium decay series, methods of measuring natural radioactivity in the air, radon and thorium given off by the earth's surface, the vertical distribution of natural radioactivity in the air on the basis of the exchange theory, measurement of natural radioactivity in the atmosphere and comparison of results with theory, natural radioactive aerosols in the atmosphere, separation processes of natural radioactivity in the atmosphere, and effects of natural radioactivity content in air on man. Results are presented in graphs and tables. (M.C.G.)

20241 (NP-12692) GOVERNORS' CONFERENCE ON HEALTH HAZARDS IN URANIUM MINES. A Summary Report. (Public Health Service. Bureau of State Services, Washington, D. C.). [1961]. 15p.

Evidence is presented for the existence of severe health hazards in uranium mines. Control of these hazards was viewed by the conferees as a primary responsibility of the States, and more aggressive action is planned to meet the problem. Upon request, various agencies of the Federal Government can provide assistance to the States in carrying out this responsibility. (auth)

20242 (NYO-9534) STUDIES OF NUCLEAR DEBRIS IN PRECIPITATION. Alan Walton and Micah W. M. Leo (Isotopes, Inc., Westwood, N. J.). Mar. 31, 1963. Contract AT(30-1)-2415. 60p.

Results are presented for the deposition of short- and long-lived radioactive nuclides at Westwood, N. J., during 1961 and 1962, and the origin of the debris during various intervals is discussed. During the two-year interval four distinct periods can be characterized according to the composition of the debris: Jan. to Sept. 1961, relatively old material most likely originating in tests performed in

1958 and earlier; Sept. 1961 to May 1962, debris predominantly from USSR trials of 1961; May to Sept. 1962, fresh debris from U. S. Pacific series of 1962 readily apparent; and Sept. to Dec. 1962, increased quantities of younger material in precipitation indicated the presence of fresh USSR debris from their 1962 testing operations. Although the fission yield of the 1961 Soviet series of tests was reportedly greater than the 1958 trials, the deposition of Sr^{90} at Westwood, N. J., was less in the first half of 1962 than in the corresponding period of 1959. An examination of the seasonal oscillations in the deposition of fallout on a global scale is presented. Spring peaks in deposition and concentration of fallout, while they appear to be universal in distribution, tend to be most probable and most pronounced in the mid-latitudes of both hemispheres. Possible mechanisms are offered to explain the nonoccurrence of seasonal variations. Under certain conditions different nuclides exhibit their maxima at different times in a given year, and the cause of this effect is discussed. (auth)

20243 (ORNL-TM-407) GAMMA DOSE RATE CALCULATIONS FOR THE BNL-KILOROD PROGRAM. F. W. Davis and E. C. Moncrief (Oak Ridge National Lab., Tenn.). Mar. 21, 1963. Contract [W-7405-eng-26]. 44p.

Gamma dose rates were calculated at various distances from a U^{233} source (containing 38 ppm U^{232}) at the operating stations of the Kilorod Facility. These dose rates, along with expected operating times at each station, were used to estimate gamma dose to the hands of operating personnel. The maximum exposure case was evaluated in which a single operator was assumed to perform all operations in the facility over a two-week period. A maximum dose to hands of 1000 mrem/man-week was obtained for the second week of operation. Actual operating practice will reduce the hand dose substantially below this value. The calculations, along with basic assumptions are reviewed. Dose rates at important operating stations or from significant pieces of equipment are plotted. (auth)

20244 (TID-18431) SUMMARY REPORT OF ACCIDENTAL NUCLEAR EXCURSION, RECUPLEX OPERATION, 234-5 FACILITY. Carl N. Zangar (Richland Operations Office, AEC). Apr. 7, 1962. 25p.

A description of occurrences associated with an accidental nuclear excursion in a 60-l glass tank (K-9) of the Hanford Recuplex facility is presented. This facility is a multipurpose Pu recovery operation for processing wastes. The plant and processes are described along with execution of the emergency plan. Measures which could have been used to avoid the accident are discussed. (J.R.D.)

20245 (TO-B-62-58) THE EFFECT OF LIMITED STRIPS OF CONTAMINATION ON THE DOSE RATE IN A MULTISTORY WINDOWLESS BUILDING. Final Report. John F. Batter, Albert W. Starbird, and Nancy-Ruth York (Technical Operations, Inc., Burlington, Mass.). Aug. 1962. Contract OCD-OS-62-14. 109p. (AD-298719)

Results are reported from an evaluation of the effects of limited fields of contamination on the dose rate within multistory structures. Comparisons were made between experimentally determined results and those obtained through use of the OCD Guide for Architects and Engineers, the National Shelter Survey Computer Program, and the OCD Manual entitled The Design and Review of Structures for Protection from Fallout Gamma Radiation. The National Shelter Survey Computer Program method for correction to account for near-field limited strips of contamination contains appreciable error, because it does not differentiate between thin- and thick-floor correction factors. Recommended experimentally obtained multiplicative correction factors for both thin and thick floors are presented. Further investigation of the effects of floor thickness and floor-edge scattering is recommended. An improved computation procedure for determining the fraction of infinite-field dose rate obtained from far-field limited strips of contamination is described. Agreement is excellent between experimentally measured and computed infinite-field dose rates. The measured dose rates in the basement are higher than predicted by computational procedures. Further below-ground-level investigation is recommended on a full-scale basement. Excellent agreement is shown between results obtained from the modeling technique on a phantom structure and previous full-scale results. (auth)

20246 (USNRDL-TR-609) A DISPERSER FOR DEPOSITING SIMULATED DRY FALLOUT MATERIAL ON LARGE ROOF SURFACES. W. S. Kehrer (Naval Radiological Defense Lab., San Francisco). Dec. 13, 1962. 28p.

A disperser was designed and constructed to disperse simulated dry fallout (graded sand) for roof washdown effectiveness tests continuously and uniformly over a 48 × 72 ft test area at a controllable dispersal rate of 0 to 4 g/min/ft^2. The major components of the system include the simulant handling equipment, the individual dispersers, the air system, and the control panel. The simulant handling equipment transports the simulant from an underground storage hopper to the individual dispersers. The specially designed items of this equipment are the 8 adjustable splitters which divide the simulant falling through each into 11 equal volume streams which in turn feed the individual dispersers. Each individual disperser consists of a sand blast nozzle located below a deflector plate. Fallout simulant and air are supplied continuously to the nozzle, which blasts it against the deflector plate; thereupon the simulant scatters and falls continuously over the test panels which are surfaced with different roofing materials. The approximate amount of this dispersed simulant that lands on each panel is determined by the following method. The simulant transported from each test panel by the washdown water during the simultaneous fallout and washdown period is collected in a sieve and weighed. The residual remaining on the test surface after washdown ceases is collected in another sieve and weighed. The total of these two weights is the amount that lands on each panel. The simulant dispersal rate to each test panel and washdown effectiveness for each are then calculated from these weights. (auth)

20247 RADIATION HAZARDS ASSOCIATED WITH X-RAY DIFFRACTION TECHNIQUES. Acta Cryst., 16: 324-8(Apr. 10, 1963).

Criteria of safety for manufacturers and users of crystallographic apparatus as to the safety-levels achieved in each type of equipment marketed are presented. Discussion is also included on sources of unwanted radiation, personnel monitoring, factors responsible for the hazards, and the various hazards. (P.C.H.)

20248 REDUCTION OF DOSE IN MEDICAL AND INDUSTRIAL RADIOGRAPHY. Hanson Blatz (New York City Office of Radiation Control, New York). Am. J. Public Health, 52: 1385-90(Sept. 1962).

In a survey in New York City, it was found that ~⅔ of all the thousands of x-ray machines used for chest radiography were using beams in excess of the liberal 24-in. dia limitation (for routine chest radiography, the most common medical radiographic technic, the 14 by 17 in. x-ray film can be completely covered by an x-ray beam of 22-in. dia).

In fact, 50% had beams in excess of 30-in. dia. For the average adult patient, this results in the direct irradiation of the eyes and gonads, thereby exposing these organs to hundreds of times as much radiation as is necessary for a satisfactory chest x-ray examination. Another common practice is the use of a fluoroscope for any x-ray examination that could be done equally well, or better, with a film. In New York City, of ~5000 fluoroscopes in use, 30% are more than 15 years old. Modern screens are twice as sensitive as 15-yr-old screens were when they were new. Fluoroscope screens are perishable and should be replaced every few years. Another important safety factor in the use of fluoroscopes is the dark adaptation of the operator's eyes. This can be aided by the use of special red dark-adaptation goggles. It is evident that extreme precautions in fluoroscopy are important when it is considered that even a properly performed fluoroscopic examination can result in 100 times the exposure of a comparable examination using a film. Other problems, presented by surveys of medical and dental radiographic practices in New York City, include the use of slow films and improper development, inadequate filtration and limitation of beam diameter, and failure to shield the patients' gonads or the operator. (TCO)

20249 MEASUREMENT OF BACKGROUND RADIATION FOR EPIDEMIOLOGIC STUDIES. Ascher Segall (Harvard School of Public Health, Boston). Am. J. Public Health, 52: 1660-8(Oct. 1962).

Methods being used in a survey of cancer incidence and its relation to background radiation in New England communities are outlined. The measurement of background radiation for epidemiologic purposes is discussed in terms of the application of technics capable of detecting geographic variation in human exposure to both external and internal natural sources of radioactivity at very low levels. The equivalent uranium content was calculated for 58 geological formations in New Hampshire, 5 in Maine, and 24 in Vermont. From this an average equivalent uranium value for the minor civil division, weighted by the proportion overlying each geological formation, was obtained. Illustrations are provided showing the distribution of geological formations and their respective equivalent uranium concentrations in minor civil divisions of New Hampshire. The findings suggest that even within small civil divisions there may be marked differences in terrestrial radiation. Radiometric analysis of small amounts of biological material, such as individual teeth, are being used to estimate the body burden of radium and other emitters in large-scale population studies. A method is described for assaying Ra^{226}, Ra^{224}, Ra^{223}, and Po^{210} in a single tooth. (TCO)

20250 PRELIMINARY STUDY FOR THE DETERMINATION OF THE AMBIENT RADIOACTIVITY. Ignacio Frisancho Pineda, Carmen Ruiz de Pardo, Mario Pizarro, and Ernesto Jibaja Torre Tagle. Bol. Inform. Junta Control Energ. At. (Peru), 7: 5p.(1962). (In Spanish)

The preliminary studies made to permit the determination of the ambient radioactivity in Lima and the first results obtained for May 1962 are reported. The reasons for the measurement of the ambient radioactivity are first discussed. The methods used for the preparation of radioactive carriers and Co^{60} standards are described. Calibration of the instrumentation used in the radioactivity measurement is discussed. In conclusion, the radioactivity measured in Lima in May 1962 is shown graphically. (J.S.R.)

20251 THE IMPLICATIONS OF THE REPORTS OF THE COMMITTEE ON RADIOLOGICAL HAZARDS TO PATIENTS (ADRIAN COMMITTEE). I. VARIATIONS IN THE RADIATION DOSE RECEIVED BY THE PATIENT IN DIAGNOSTIC RADIOLOGY. S. B. Osborn (King's Coll. Hospital, London). Brit. J. Radiol., 36: 230-4(Apr. 1963).

A survey of the radiation dose received by patients during diagnostic radiology revealed a wide variation in the dose received by the patient for a given type of examination. The variations in dose were attributed to factors that vary independently over a wide range. A number of them could be controlled, or their range could be restricted, and dose to the patient reduced. It is pointed out that patients and their illnesses show a wide variation and that a given patient will be examined in different ways by different radiologists. These factors contribute to variations in radiation dose received by patients. (C.H.)

20252 THE IMPLICATIONS OF THE REPORTS OF THE COMMITTEE OF RADIOLOGICAL HAZARDS TO PATIENTS (ADRIAN COMMITTEE). II. COMMENTS ON THE DIAGNOSTIC ASPECTS OF THE ADRIAN COMMITTEE REPORTS. G. M. Ardran (Atomic Energy Research Establishment, Harwell, Berks, Eng. and Oxford Univ.). Brit. J. Radiol., 36: 235-7(Apr. 1963).

Radiological hazards to patients during diagnostic radiology are discussed. Improvements in radiation protection made since 1956 are stressed. (C.H.)

20253 THE IMPLICATIONS OF THE REPORTS OF THE COMMITTEE ON RADIOLOGICAL HAZARDS TO PATIENTS (ADRIAN COMMITTEE). III. INTERIM REPORT ON THE DETERMINATION OF DOSE TO BONE MARROW FROM RADIOLOGICAL PROCEDURES. F. W. Spiers (Univ. of Leeds, Eng.). Brit. J. Radiol., 36: 238-40 (Apr. 1963).

The distribution of active bone marrow was derived and calculations were made of mean marrow dose during diagnostic radiography. The mean marrow dose was calculated by computer for each of 5,400 examinations measured in a physical survey. Results indicate that doses to the marrow from different types of examination differ considerably and some examinations are major contributions to marrow dose but contribute little to the gonad dose. (C.H.)

20254 THE IMPLICATIONS OF THE REPORTS OF THE COMMITTEE ON RADIOLOGICAL HAZARDS TO PATIENTS (ADRIAN COMMITTEE). IV. POSSIBLE CONSEQUENCES OF RADIOGRAPHIC TISSUE DOSE. R. H. Mole (Medical Research Council, Harwell, Berks, Eng.). Brit. J. Radiol., 36: 241-6(Apr. 1963).

Data are reviewed from a series of surveys on the leukemogenic and carcinogenic effects of radiation in man. The data are discussed in relation to the radiation dose received during diagnostic radiographic procedures. (C.H.)

20255 RADIOACTIVITY AND HARDNESS OF DRINKING WATERS IN RELATION TO CANCER MORTALITY RATES. R. C. Turner (Royal Cancer Hospital, London). Brit. Waterworks Assoc. J., 44: 613-29(Oct. 1962).

A study of mortality rates for cancer of different sites and for a number of other diseases did not reveal any correlation between area mortality and the widely different amounts of Ra^{226} and its daughter products known to be present in the drinking waters available in England and Wales. The areas of Wales that show surplus mortality from gastric cancer possess drinking water supplies with very low contents of natural radioactivity. Surplus gastric cancer tends to appear in regions having soft drinking waters derived from surface drainage, and often having a low pH at their source. Surplus mortality rates, due to diabetes mellitus among females and to vascular lesions

affecting the central nervous system in both sexes, also appear in the soft water regions of England and Wales. This trend is not displayed by cancer of other sites nor does it appear in the mortality data for a number of other diseases. (TCO)

20256 THE POTENTIAL RADIATION HAZARD ASSOCIATED WITH THE OPERATION OF NUCLEAR REACTORS IN THE FUTURE. C. G. Stewart (Atomic Energy of Canada Ltd., Chalk River, Ont.). Can. Med. Assoc. J., 87: 740-4 (Oct. 6, 1962).

The 12-yr safety record of the largest reactor installation in Canada is reviewed. Methods of disposal of radioactive reactor wastes at the Chalk River Project are also described. It is believed that large reactors can be built and operated without unacceptable risk either to employees in the reactor site or to the public. Furthermore, on the basis of the principles applied to the design and operation of the reactors at Chalk River, it is the considered opinion of the reactor engineering staff at the Project that the risk to operating personnel and to the public will not become greater than that associated with other industrial activities of comparable size. Disposal and dispersal of radioactive wastes, ventilation, and monitoring are discussed. The Ottawa River and its fish are examined regularly for radioactivity. The Sr^{90} levels in the river, as an index of radioactive escape, are the same within the precision of measurement above and below the Project and are attributable to weapons fallout; so far no Sr^{90} is detected in the bones of fish taken from the river in the vicinity of the project in excess of $^1/_{10}$ of the concentration permitted as safe in the bones of atomic energy workers. (TCO)

20257 INFLUENCE OF RADIATIONS ON THE POPULATION. Hans Nachtsheim. Europa Nucl., 5: No. 6, 11-16(Nov.-Dec. 1962). (In German)

The effects of the radiations to which man is daily exposed are reported. After both the direct somatic and latent genetic effects of radiation are indicated, the problem of the varying radiosensitivities of individuals and individual organisms is discussed. The arguments on the maximum permissible total radiation dose from conception on are reviewed. The effect of the "small sources" of radiation, such as TV sets, phosphorescent watch dials, etc., is examined. (J.S.R.)

20258 FACTS AND FALLACIES OF CHEST FLUOROSCOPY. Otto Deutschberger and David Scherf (New York Medical Coll., New York). Exptl. Med. Surg., 20: 17-30 (Mar.-June 1962).

A comparison is made of x-ray doses received by patients undergoing chest radiography and cardiac and gastrointestinal fluoroscopy, and the possible hazards of such radiation doses are discussed in relation to the diagnostic benefits of the procedures. Fluoroscopy of the gastrointestinal tract delivers 3 to 5 times the dose given by chest fluoroscopy. Fluoroscopy of the chest delivers 5 r under average conditions and 2.5 r under optimal conditions to the patient's skin in the region of the thorax during one routine examination. The biological effect of this dose computed for the volume of the entire body corresponds under average conditions to whole-body irradiation with 0.1 r or $^1/_{50}$ of the threshold dose. Average monthly dose received in fluoroscopic work is estimated to be 0.1 r. It is suggested that since fluoroscopy of the chest can be performed with $^1/_{50}$ of the yearly threshold dose, there is no hazard with regard to producing tissue injuries, carcinogenesis, or genetic changes. In fluoroscopy of the chest the ovaries receive 0.014 r. It was concluded that routine fluoroscopy for the diagnosis of cardiac diseases cannot be considered unnecessary because it gives unique information, often unobtainable by other methods of examination, and for the diagnosis of cardiac disease in adults, fluoroscopy of the chest should be performed routinely. However, fluoroscopy in infants and young children should be restricted for any region to special cases. Fluoroscopy of the chest can be performed safely and many times within the limits of the recommended threshold dose provided that the fluoroscope meets with the prescribed safety specifications and the examiner is properly trained. (TCO)

20259 HIGH-VOLTAGE ROENTGENOGRAPHY OF FETUS. Shigeru Nakagawa and Shigetoshi Antoku (Hiroshima Univ.). Hiroshima J. Med. Sci., 11: 11-29(June 1962).

The possibilities of reducing radiation exposure of the ovaries and fetal organs during abdominal radiodiagnostic examination of pregnant women were explored by the use of high-voltage x rays. Depth doses were measured in a water phantom using x rays varying in intensity from 60 to 140 kvp. Comparison between the use of intensifying screens at 80 and 140 kvp revealed that the dose to the gonads of the fetus with the latter was $^1/_5$ and that to the gonads of the mother was $^1/_3$ as compared with 80 kvp. At the same voltage, changing the filter to remove soft rays decreased the irradiation dose further. Comparison of 80 kvp (1.5 mm Al filter) with 140 kvp (0.2 mm Cu + 1.0 mm Al) revealed that the irradiation dose to the gonads of the fetus with the latter was $^1/_6$ as compared with the former voltage and the irradiation dose to the gonads of the mother was $^1/_3$. The higher the voltage, the lower the bone shadowing ability and the more unclear the film becomes. Hence, it was confirmed that by elevating voltage and using adequate filters and intensifying screens, the irradiation dose can be decreased. It is believed that the advantages of high-voltage radiography in reducing fetal and maternal gonadal exposure outweigh the disadvantage of the lower differential density of bone and soft tissues. (TCO)

20260 RADIOLOGICAL CONTAMINATION OF LIVESTOCK AND FOOD. James D. Lane. Illinois Veterinarian, 5: No. 2, 13-17(1962).

20261 RADIATION PROTECTION OF DENTAL PERSONNEL. Aaron Trubman (Mississippi State Board of Health, Jackson). J. Am. Dental Assoc., 65: 751-4(Dec. 1962).

Responsibilities of dentists in reducing exposure to themselves and their assistants below the maximum permissible limit (0.1 r per week) are discussed. Modifications of equipment suggested for reducing occupational radiation exposure to dental personnel are: filtration to a total of 2.5 mm of Al should be used in units operating above 70 kvp, and 1.5 mm for those operating up to 70 kvp; a Pb jacket should be inserted in the housing to prevent excessive leakage, if necessary; collimation by means of a Pb diaphragm should be used to reduce the diameter of the primary beam at the tip of the cone to 3 in.; and the timer cord should be of sufficient length to permit the operator to be at least 6 ft away from the primary beam and patient during exposure. Modifications of technic suggested to reduce exposure are: shields or screens should be used where the minimum distance of 6 ft cannot be maintained; the operator should assume a position that will enable him and assisting personnel to be in back of the primary beam, or if this is not possible, the position should be at right angles to the beam and preferably behind the patient; exposure times should be kept to a minimum while still obtain-

ing good roentgenograms; and the path of the primary beam should be directed toward an outside wall. Film badge service is recommended as an inexpensive, simple means to determine whether, through fault of equipment or technic, personnel are receiving excessive radiation. (TCO)

20262 RADIOACTIVITY IN THE DIET. Gordon M. Dunning (U. S. Atomic Energy Commission, Washington, D. C.). J. Am. Dietet. Assoc., 42: 17-28(Jan. 1963).

An extensive survey is presented of data collected from various sources relating to radionuclides, both naturally occurring and originating from fallout, in diets in different geographic areas of the United States. Data are also provided showing the bone doses of Sr^{90} and thyroid doses of I^{131}, and the possible hazards of retained doses to the health of individuals of various age groups are discussed. In general, it is estimated that from $\frac{1}{3}$ to $\frac{1}{2}$ of the dietary intake of Sr^{90} is from liquid milk, $\frac{1}{4}$ from cereals, and 4 to 8% from eggs, fresh meat, and poultry. In general, it appears that the highest daily average intake reported was about 17 Sr units (1 unit = 1 $\mu\mu$c Sr^{90}/g Ca) for 1961–62. From assays of Sr^{90} in human vertebrae, it can be seen that the highest value (3.5 Sr units) in the bone in 1961–62 corresponds to about 10 Mrem per year to bone and about 4 Mrem to bone marrow. Monitoring programs indicate that I^{131} levels accumulated during 1961 to a value such that the estimated radiation dose to the thyroid of young children is about $1\frac{1}{2}$ times the annual background from naturally occurring materials, as a national average, and about 5 times the annual background in several areas. There is some evidence that the amounts of I^{131} in human thyroid may be less than the estimates. It also appears that I^{131} is considerably less effective than comparable doses of externally applied x rays in producing thyroid cancer, x rays being from 5 to 15 times as effective as I^{131}. The radionuclide maximum permissible doses recommended by the Federal Radiation Council Radiation Protection Guides are discussed, and possible measures for removal of Sr^{90} and I^{131} from milk are outlined. It was concluded, however, that their present levels do not warrant adoption of such measures. (TCO)

20263 PERMISSIBLE RADIATION EXPOSURE LEVELS. Ek Djin Oei (Central Hospital, Djakarta, Indonesia). Madjalah Kedokteran Indones., 11: 76-8(Feb. 1961).

The recommendations of the International Commission for Radiological Protection are discussed. (H.H.D.)

20264 THE ASSESSMENT OF BETA-EMISSION AS A RADIATION FACTOR IN PERSONS WORKING ON THE CYCLOTRON. L. V. Kuznetsova and M. S. Egorova. Med. Radiol., 8: No. 3, 34-8(Mar. 1963). (In Russian)

An evaluation was made of the radiation effect of beta-emission on the personnel operating the cyclotron. The approximate doses of gamma- and beta-irradiation for a week are given. The average maximal energies of beta-radiation were determined. (auth)

20265 RADIATION HAZARDS FROM THE STANDPOINT OF THE PRACTICING PHYSICIAN. Hanson Blatz (New York City Office of Radiation Control, New York). N. Y. State J. Med., 62: 3893-8(Dec. 15, 1962).

The experience of the New York City Office of Radiation Control in inspecting radiodiagnosis equipment of dentists and physicians is described. Many cases were found of neighbors being subjected to much higher radiation doses than the limits recommended because of x-ray equipment installed, for example, in a building directly above a superintendent's maintenance room, a children's bicycle storage area, or an automatic laundry room located in an apartment house basement. The most important aspect of radiation control and the most difficult to administer is the elimination of unnecessary exposure to the patient. The most common cause of excessive exposure is the failure to limit the radiation beam to areas of clinical interest. Inspections showed that in chest x-ray examinations more than $\frac{2}{3}$ of the equipment checked in New York City was provided with cones that exposed a much greater part of the body than was necessary to cover the x-ray film. In many cases the entire body, including the gonads, was being exposed, thereby resulting in a gonadal exposure many hundreds of times more than was actually necessary for chest films. Moreover, conditions used for development of films were often found to be unsatisfactory so that the dose to the patient was increased to obtain adequate image density. Many physicians perform routine chest x-ray examinations with fluoroscopes rather than with radiographic units employing films. Such examinations involve ~100 times as much radiation as if a film were used. Since more fluoroscopes than radiographic units employing films are registered in New York City, the use of fluoroscopy appears to be excessive. (TCO)

20266 RADIOACTIVITY FOLLOWING NUCLEAR WEAPONS TESTING. J. Blok. Ned. Tijdschr. Geneesk., 106: 1494-1501(July 21, 1962).

A review of the biological effects of radionuclides and discussion of hazards of fallout are presented. (H.H.D.)

20267 THE REDUCTION OF UNNECESSARY X-RAY EXPOSURE DURING INTRAORAL EXAMINATIONS. Robert A. Goepp, Nels M. Strandjord, Paul C. Hodges, and Robert D. Moseley, Jr. (Univ. of Chicago). Oral Surg., Oral Med., Oral Pathol., 16: 39-45(Jan. 1963).

A cone-collimating device that collimates the beam to a rectangle, eliminates plastic-pointer scatter, controls aluminum-filter and air scatter, and can be used with the techniques currently employed is described for use with dental x-ray apparatus. The cone is constructed of radio-opaque materials that collimate the primary beam to a rectangular field. The cone was designed in 2 parts; the proximal (round) part was made of 16-gauge steel tubing, 7.5 cm in dia, and the distal part of 18-gauge cold-rolled steel. Rectangular collimation of the beam reduces the primary irradiated skin surface area by 36% from that of the 2.75-in. dia circular beam, so that the gonadal dose should be 55% less when the maxillary incisor area is irradiated. The metal cone effectively controls the aluminum-filter and air scatter outside the primary beam area. With the reduction in the volume of tissue irradiated, there is much less tissue scatter, and an appreciable improvement in the quality of film contrast was noticed. It was concluded that the use of a rectangular collimated field of 4.5 by 5.5 cm with a roentgen-opaque metal cone is a practical method for considerably reducing unnecessary exposure in periapical intraoral roentgenographic examinations. (TCO)

20268 A SURVEY OF DENTAL X-RAY UNITS IN USE IN THE UNITED STATES NAVY. George O. Stead (Bureau of Medicine and Surgery, Navy Dept., Washington, D. C.). Oral Surg., Oral Med., Oral Pathol., 16: 250-2(Feb. 1963).

A survey was made of all 485 dental x-ray units in use throughout the United States Navy to check the total filtration (inherent and added), symmetry and diameter of the useful x-ray beam, and the leakage from the portal end of the tube head. It was found that all but 39 units were operated at below 70 kvp. Filtration readings ranged from 0.6 mm of Al to 3 plus. Beam-diameter readings ranged from 1.2 to 7.5 in. The criteria used to determine an x-ray

unit's need for corrective procedures were based on filtration with 2 mm Al up to 70 kvp and 2.5 mm above 70 kvp, and maximum beam diameter of 3.0 in. 277 units met the criteria established for filtration and 325 had a beam of 3.0 in. or less. A comparison was made between these units and 9950 units surveyed by the State Services Branch, Division of Radiological Health, United States Public Health Service. The use of high-speed film, electronic timers, and protective screens and lead-impregnated plastic and rubber aprons was recommended. (TCO)

20269 RADIATION AND CHILD HEALTH. Francis J. Weber and W. H. Hetznecker (Public Health Service, Washington, D. C.). Pediatrics, 28: 147-58(July 1961).

The responsibilities of physicians and public health officials in assuring that environmental sources of radiation do not interfere with child development and health are discussed. Since there are still many unresolved questions in this area it is necessary to know how to view the established limits. The present limits should be regarded with a cautious optimism; efforts to remain within them will insure improved human health protection, regardless of what point on the scale of values the true limit ultimately comes to be set. Since the effects of very small doses of radiation in man are unknown, a conservative approach to establishing radiation exposure guides is called for. It is suggested that, in addition to medical x rays, an increment of exposure from proved beneficial sources to a degree equal to natural background may be added, but that any activities which entail increases beyond that must be viewed with concern. The weight of reviewed evidence supports the hypothesis that ionizing radiation can be a cause of leukemia and other neoplastic diseases in children. It appears definite that the fetus and infant are more sensitive to radiation exposure than are older persons. In addition, it is likely that the dose-response curve is linear, at least in doses above the neighborhood of 100 r. The research program of the Division of Radiological Health is described in detail. (TCO)

20270 GENETIC HAZARDS OF RADIATION. W. L. Russell (Oak Ridge National Lab., Tenn.). Proc. Am. Phil. Soc., 107: 11-17(Feb. 1963).

The genetic hazards of radiation are reviewed. Results are presented from recent studies on mice that indicate that the hazard in man may be larger than has been anticipated, and that some of the principles of radiation genetics that were believed to be quite general are valid only under some conditions. Topics discussed include the radioinduced mutation rate in male mice and the effect of radiation dose rate in male and female mice. (C.H.)

20271 RADIATION HAZARDS. John Innes (Victoria Infirmary, Glasgow). Radiography, 18: 241-7(1962).

Radiation from natural sources to which the population is exposed is considered, and the present assessment of additional radiation from man-made sources is reviewed, with special reference to diagnostic radiology. The effects of radiation on the human body are discussed, both somatic and genetic. Dosage from diagnostic radiology should be kept to the minimum necessary, and measures to ensure this are mentioned. (auth)

20272 SUMMARY OF STATE DENTAL RADIOLOGICAL HEALTH ACTIVITIES. James W. Miller. Radiol. Health Data, 4: 41-5(Jan. 1963).

Approximately half of the x-ray machines in the country are owned and operated by dentists. There are approximately the same number of dental x-ray machines as there are dentists, and the number of dental films exposed each year is approximately equal to our population. Radiation hygiene surveys have been and are being conducted to ascertain the awareness of the dental profession to potential hazards from radiation and the steps taken to reduce the dosage to patients and dental personnel. The extent of the surveys and the extent of radiological health programs and legislation in the various states are summarized. (TCO)

20273 MEDICAL PROBLEMS OF MANNED SPACE FLIGHT. O. G. Gazenko (Academy of Sciences, Moscow). Space Sci. Revs., 1: 369-98(Mar. 1963). (In English)

A survey of medical problems of human flight into space on the basis of experimental research carried out in the USSR is presented. (C.E.S.)

20274 ZASHCHITA NASELENIYA V USLOVIYAKH PRIMENENIYA ATOMNOGO KHIMICHESKOGO I BAKTERIOLOGICHESKOGO ORUZHIYA. (Civil Defense Against Atomic, Chemical, and Bacteriological Attack). G. F. Baratov. Kiev, State Medical Publishing House, Ukrainian SSR, 1962. 424p.

Data are given on various types of air attack and principles and performance of various nuclear, chemical, and bacteriological weapons. Protection against ionizing radiation in handling radioactive materials and sources is discussed. First aid measures, therapeutic prophylaxis, quarantine, disinfection, and other measures applicable in civilian protection against nuclear and thermonuclear attack are considered. (R.V.J.)

20275 TEKHNIKA BEZOPASNOSTI PRI RABOTE S RADIOAKTIVNYMI VESHCHESTVAMI. (Safety Techniques in Handling Radioactive Materials). V. N. Shikhov. Moscow, Mashgiz, 1962. 88p.

Protective measures in handling radioisotopes, considering the up-to-date safety requirements, are considered. Radiation effects on human organism, permissible doses, dosimetric control, personal hygiene, and working clothes are discussed. 36 references are included. (R.V.J.)

20276 ESTIMATING DAILY EXPOSURES OF UNDERGROUND URANIUM MINERS TO AIRBORNE RADON DAUGHTER PRODUCTS. R. C. Bates and R. L. Rock. U. S. Bur. Mines, Rept. Invest., No. 6106, 1962. 22p.

The daily exposure of uranium mine workers to radon daughters was estimated by 2 methods of sampling, detailed and spot check. The breathing zones of 8 workmen in 3 underground uranium mines were sampled for an entire shift; 20 to 36 radon daughter samples were collected per man-shift. Analysis indicated that a suitably accurate estimate for the full-shift exposure could be made by time weighting a lesser number of representative radon daughter samples. Additional detailed studies were made in 7 mines to learn more about the full-shift radon daughter exposures and to test the spot check method. The method is recommended for use by the mining companies, government agencies, and others who wish to evaluate the radon daughter exposures of uranium mine workers. The spot check method is simple, fast, and gives a reasonably accurate estimate of the full-shift exposure. (auth)

20277 IMPROVEMENTS IN OR RELATING TO SHIELDED CONTAINERS FOR NUCLEAR FUEL ELEMENTS. David John Ashcroft (to United Kingdom Atomic Energy Authority). British Patent 924,013. Apr. 18, 1963. Filed May 24, 1960.

A shielded container is designed for temporary storage of irradiated fuel elements during transfer from a ship reactor to a relatively small water pond on board. The container comprises two mating tubular parts, the first having a closed lower end and an open upper end and the second having an open lower end and a closed upper end,

a fuel element magazine demountably located in the first part, an opening in the wall of the first part for sideways removal of the magazine, and a port in the closed end of the second part for endwise loading of fuel elements into the magazine. The operation of the container is described in some detail. (D.L.C.)

20278 PROTECTIVE HOUSING FOR RADIOACTIVE SOURCES. Irwin Ginsburgh and Herbert G. J. Myers (to Standard Oil Co.). U. S. Patent 3,085,157. Apr. 9, 1963. Filed July 30, 1959.

The design of a container or housing for radioactive materials is given. The housing can also be used when such materials are employed in industrial locations. Essentially the container houses a radioactive source within a shield of dense material, and the assembly of source and shield is disposed entirely within an insulating refractory box or container made of high-melting low-thermal conductivity material. Shielding materials used are dense materials, which attenuate radiation from the source and afford biological protection to personnel working in the area. (P.C.H.)

INDUSTRIAL APPLICATIONS OF ISOTOPES AND RADIATIONS

20279 (NP-12679) RADIOACTIVE NUCLIDES AND THEIR RADIATIONS AS AN IMPORTANT TOOL FOR THE BENEFIT OF LESS DEVELOPED AREAS. H. Seligman, J. Cameron, M. Cohen, E. Eriksson, B. R. Payne, R. Olson, and H. Vetter (International Atomic Energy Agency, Vienna). [nd]. 9p.

Applications of radioactive isotopes in industry, medicine, agriculture, and hydrology are reviewed. Uses of isotopes as radiation sources and as traces are discussed briefly. (C.H.)

20280 (JPRS-17530) BIOCHEMICAL ASPECTS OF THE RADIATION METHOD OF FOOD PRESERVATION. L. V. Metlitskii (Metlitskiy). Translated from Izv. Akad. Nauk SSSR, Ser. Biol., [27], 869-84(1962). 37p. (OTS-63-20178)

Problems involved in the radiation processing of foods to increase storage life are reviewed. It is pointed out that ionizing radiation can alter biochemical processes in food during storage. The effects of radiation on potatoes, vegetables, fruits, beef, poultry, and meat products are discussed. It is concluded that the extensive use of radiation for food processing requires further development. (C.H.)

20281 USES OF RADIOACTIVE MATERIALS IN INDUSTRY. L. B. Leppard (Ontario Dept. of Public Health, Toronto). Can. J. Public Health, 53: 109-15(1962).

Safety precautions to be observed in handling radioactive materials are discussed, and their industrial applications are outlined. The applications include uses such as monitoring, metering, detection, radiography, tracing leaks, static elimination, fire-alarm systems, luminous dials of gages, and reactor fuel. Problems encountered in the handling of radioisotopes and disposal of wastes are also considered. (H.H.D.)

20282 THE WINNING OF ELECTRICAL ENERGY FROM RADIOACTIVE ISOTOPES. P. Wenzel. Energietecknik, 12: 504-7(Nov. 1962). (In German)

After detailed statements of general viewpoints, such as the selection of suitable isotopes, the various well-known nuclear batteries are described. (tr-auth)

20283 COLD STERILIZATION. Josef Wierzchowski. Farm. Polska, 18: 277-83(June 25, 1962).

The use of ionizing radiation for sterilization of pharmaceutical preparations is discussed. (H.H.D.)

20284 DIE TECHNISCHEN ANWENDUNGEN DER RADIOAKTIVITÄT. BAND I. (The Technical Applications of Radioactivity. Volume I). Engelbert Broda and Thomas Schoenfeld. Leipzig, Veb Deutscher Verlag fur Grundstoffindustrie, 1962. 372p. 32.50 DM.

Possible uses of radioactivity are discussed and references to specific examples are given. An introduction to nuclear physics principles, radiation measurement techniques, and preparation and chemistry of radioelements is included. A comprehensive discussion is presented on the uses of radioactivity in chemical analysis, mining and oil production, metallurgy, pressure technology, soil and forest management, water management, as well as the following industries: machinery, electricity, chemistry, cellulose, paper, textile, photography, and glass and construction materials. (M.C.G.)

20285 EFFECTS OF IRRADIATION ON MORTALITY AND REPRODUCTION OF A CEREALS PEST, SITOPHILUS SASAKII TAKAHASHI (CURCULIONIDAE) AND STUDY OF THE INFLUENCE OF TREATMENT ON OFFSPRING. P. Laviolette and P. Nardon (Institut National des Sciences Appliquees, Lyon). IAEA Preprint SM-40/4. 12p. (In French)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Cobalt^{60} irradiation of Sitophilus sasakii brought gamma about a significant reduction in expectation of life. Five thousand r were effective in the case of males with 7000 r in that of females. All insects died within about twelve days after a dose of 8000 r and within four days after 100,000 r. Study of the pattern of mortality as a function of time shows that, up to 6000 r, irradiation induces a progressive heterogeneity in the population, the more resistant individuals being isolated. Examination of the survival curves shows that death is always deferred. It occurs suddenly after a latent phase, the duration of which varies, according to dose, between twelve days (5000 r) and one day (100,000 r). Study of the variability coefficient and of the average survival time according to dose suggests that two sensitive mechanisms are destroyed by irradiation. Radiosensitivity appears to increase with age. Fertility is reduced by half as from 2000 r. A period of temporary sterility appears at 5000 and 6000 r, and complete sterility sets in at 15,000 r. Sterilization by x-rays is more effective at 150 than at 80 Kv. Egg production is much more radioresistant than fertility, eggs being laid even at 16,000 r. Irradiation of parents induces a decrease in both fertility and weight of offspring and slows the latter's rate of development. These effects are transmitted to succeeding generations without any effort at selection on the part of the experimenter. The first two effects tend to disappear, but the decrease in the rate of development remains constant for at least ten generations. It would seem possible to use radiation for disinfestation of foodstuffs. (auth)

20286 STUDIES ON THE EFFECTS OF GAMMA RADIATION ON THE DIFFERENT DEVELOPMENTAL STAGES OF THE KHAPRA BEETLE, TROGODERMA GRANARIUM EVERTS. K. K. Nair and G. W. Rahalkar (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-40/27. 18p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Different stages in the development of the Khapra beetle were exposed to various doses of gamma radiation and their effects recorded. It was observed that the females were more susceptible to gamma radiation than the males. A dose of 6000 rads induced sterility in the females whereas the males required 16,000 rads for complete sterility. The reasons for such differences are discussed. (auth)

20287 USE OF ISOTOPES FOR INVESTIGATING THE BEHAVIOUR AND ECOLOGY OF INSECT PESTS IN SOME RECENT STUDIES. M. S. Quraishi (CENTO Inst. of Nuclear Science, Teheran). IAEA Preprint SM-40/20. 7p. (In English)

Anopheles stephensi is the main vector of malaria in southern Iran. Using P^{32} labelled mosquitoes, the dispersal, behavior, digestion of blood meal, maturation of ovaries, and length of gonotrophic cycles were successfully worked out. It was found that in about 80% of the cases the mosquito needed two blood meals for the completion of the first cycle. The first cycle itself was completed in 4 to 5 days depending upon the temperature. Labeled mosquitoes which had emerged overnight were released in an isolated village. The ratio of active mosquitoes to total catch was worked out every day and thus assuming that the natural population remained constant, the mortality rate, which was found to be exponential for the first six days, was worked out. Mating behavior of the female was also studied by using normal females which had mated once with P^{32} labeled males. It was found that the female mates more than once and that after mating with an active male, the spermatheca became active. Counts of up to twice the background (12 cpm) were obtained by using males giving about 15,000 counts per minute. Studies on the injection of saliva in glucose solution during feeding were also made using P^{32}-labeled mosquitoes. Eurygaster integriceps is a serious pest of wheat in Iran, Pakistan and the Middle East. Using P^{32}-activated wheat plants, the feeding behavior of the first instar nymph was investigated. Other foods, radioactively labeled, were also studied and it was found that feeding was essential for the first moult, even if the food consisted of water absorbed in a filter paper. (auth)

20288 RADIOSENSITIVITY OF VARIOUS STAGES OF CALLOSOBRUCHUS CHINENSIS L. M. S. Quraishi and M. Metin (CENTO Inst. of Nuclear Science, Teheran). IAEA Preprint SM-40/19. 7p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

The effects of irradiation on the eggs, larvae, pupae and adults of Callosobruchus chinensis L., a destructive pest of stored leguminous seeds, were studied. Since the entire life cycle except the egg and adult stages of this insect is passed in the seed itself, control by conventional means is very difficult. It was found that a dose of 15,000 rads gave 100% mortality in the case of eggs. Different doses below this level gave somewhat variable results and it is possible that there is a sensitive stage for a short period during the first 24 hours of development of the eggs. In the case of 8-day-old larvae 100% mortality was obtained with a dose of 20,000 rads. The pupae seem to be less radiosensitive than the eggs or larvae and doses of 47,000 rads were needed to give 100% mortality. Doses of 42,000 rads sterilized the males and females in the sense that, though mating took place after irradiation, the eggs produced when either of the parents had been irradiated with a dose of 42,000 rads did not hatch. Production of sterile eggs continued even when either or both parents had been exposed to doses of 67,000 rads. (auth)

20289 PRELIMINARY STUDIES ON IRRADIATION OF SOME COMMON STORED GRAIN INSECTS IN PAKISTAN. H. Huque (Ministry of Food and Agriculture, Karachi, Pakistan). IAEA Preprint SM-40/18. 11p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Response of some major insect pests of stored grains to various radiation dosages from a Co^{60} source was studied. A dosage of 20,000 r gave 100% mortality of the adults of Rhizopertha dominica and Tribolium castaneum within a period of 11 days. A lower dose of 10,000 r was however effective in 23 days. The adults of Sitophilus granarius evinced much comparative susceptibility and when exposed to 10,000 r, total mortality was given in 7 days. The larva of Trogoderma granarium however proved to be the most resistant; not responsive to lower dosages, 100% control was attained only with 25,000 r in 26 days. Though the maximum dosage of 250,000 r gave an instant kill in all these cases, it adversely affected the viability of the grains. The nutritive value however being unaffected, this could be of use where immediate disinfestation of non-seeding edible grains was desired. Eggs of Bruchus quadrumaculatus failed to hatch when exposed to 2500 r. Studies on other stages and dosages are in progress. (auth)

20290 THE EFFECTS OF GAMMA RADIATIONS ON THE OVARIES OF DACUS OLEAE GMEL. B. Baccetti and R. De Dominicis (Università, Florence). IAEA Preprint SM-40/41. 40p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Cytological and ultramicroscopical techniques were used to study the ovaries of unfertilized adult females of Dacus oleae irradiated in the central period of the pupal stage with several doses (from 2000 to 30,000 r) of gamma rays. The treatment in any case inhibits the normal development of the ovary. Nurse cells and egg cells are very little, scarce in number, and with abnormal structure and ultrastructure, essentially concerning the cytoplasmic organelles. (auth)

20291 EFFECTS OF VARIABLE DOSE RATES ON RADIATION DAMAGE IN THE RUST-RED FLOUR BEETLE, TRIBOLIUM CASTANEUM (HERBST). K. K. Nair and G. Subramanyam (Atomic Energy Establishment, Trombay, India). IAEA Preprint SM-40/28. 8p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

In order to find out whether a change in dose rate would significantly alter a radiation response, eggs as well as the adults of Tribolium castaneum were tested for viability and fertility respectively after exposure to gamma radiation at different dose rates. The doses employed were 2000 and 5000 rads and the dose rates ranged from 126 rads/hr to 140,000 rads/hr. It was observed that with an increase in dose rate there was a decline in fertility of the adults. Similarly the viability of the eggs was considerably reduced at higher dose rates. The significance of these findings is discussed. (auth)

20292 APPLICATION OF RADIOISOTOPES TO STUDY OF THE BEHAVIOR OF SOME COTTON-PLANT PESTS IN AFRICA. R. Delattre (Institut de Recherches du Coton et Textiles, Paris). IAEA Preprint SM-40/1. 9p. (In French)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Phosphorus^{32} and S^{35} were used to label cotton plants

in studies of the life cycle of Diparopsis watersi, an insect whose larvae destroys both the flower and the ball of cotton plants. Results of studies on labeled larvae coming to maturity at critical periods of plant development will be used to develop an effective control. (C.H.)

20293 RADIOAUTOGRAPHY IN THE STUDY OF RADIOISOTOPICALLY-TAGGED INSECTICIDES. D. L. Joftes (New England Deaconess Hospital, Boston). IAEA Preprint SM-40/32. 25p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Radioautographic procedures are described for use in studies of the metabolism of labeled insecticides by insects. Techniques and equipment are discussed in detail. (C.H.)

20294 ERADICATION OF WHITE GRUB (MELOLONTHA VULGARIS F.) BY THE STERILE-MALE TECHNIQUE. E. Horber (Station d'Essais Agricoles, Zurich). IAEA Preprint SM-40/12. 24p. (In English)

To be published in the Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Eradication of the cockchafer (Melolontha vulgaris) by release of radiation-sterilized males was accomplished in an area that is not strictly isolated geographically. The white grubs, or larval stage of development of these insects, feed on root crops such as potatoes and sugar beets, other vegetables, strawberries, and young nursery stock. These insects require 3 years for their development from egg to adult and the flight period of the females is concentrated in a few weeks every 3 years. Results are reported from experiments on eradication in Switzerland over a 9-year period. Laboratory tests indicated x-ray doses of 3,000 r were sufficient to enduce sterility in male cockchafers. The sterilized males were released among a natural population during female flight periods. The irradiated males were marked with a leather dye and females were labeled with P^{32} to facilitate population studies. (C.H.)

20295 SOME USES OF RADIOISOTOPES AND RADIATION IN ENTOMOLOGY. G. Courtois (Centre d'Etudes Nucléaires, Saclay, France) and J. Lecomte. IAEA Preprint SM-40/5. 20p. (In French)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Recent developments in applications of radioisotopes in entomology are reviewed. $Gold^{198}$ and P^{32} were used as tracers in studies on the life history of social insects. Results are reported from studies on radius of dispersal from a colony, food exchange, and division of responsibility in honey bees, ants, and wasps. The uptake of natural and artificial radioisotopes by ants was studied. A radioautographic method was developed for studies on the distribution of P^{32} and S^{35} in the body of bees. An attempt was made to label acridians with Ir^{192}. (C.H.)

20296 STUDIES ON THE SELECTIVE TOXICITY OF SCHRADAN. T. Saito (Nagoya Univ., Aichi, Japan). IAEA Preprint SM-40/17. 7p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Schradan is low toxic to chewing insects, while it is highly toxic to sucking insects. The selective toxicity of schradan may be associated with distribution of toxicants in insect bodies, susceptibilities of insect cholinesterases to toxicants, and metabolism of toxicants. The absorption, excretion, and metabolic rates of P^{32}-schradan in 6 insects varied considerably and definite relationships were not found between those factors and toxicities, nor between susceptibility of cholinesterases to toxicants and toxicities. But quantitative differences in P^{32}-schradan distribution patterns existed between the insects. Much more P^{32}-schradan accumulated in the central nervous systems of sucking insects than in those of chewing insects. Isolated nervous tissues of sucking insects absorbed much more P^{32}-schradan than those of chewing insects. With electron microscopical observation on central nervous sheath, the thoracic ganglia of chewing insects were enclosed in thick and robust sheath, while those of sucking insects were surrounded by simple and thin double membranes. It was concluded that the selective toxicity of schradan to insects was not due to the difference of their metabolizing activities of schradan in activation and detoxication nor to the sensitivity of insect cholinesterases to activated schradan, but to the differences of schradan distribution patterns in insect bodies. (auth)

20297 EFFECTS OF IONIZING RADIATION ON INSECTS AND OTHER ARTHROPODS. W. E. Stone (Department of Agriculture, Mexico City). IAEA Preprint SM-40/36. 15p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Research is reviewed on the development of radiation sterilization methods of population suppression for control of a number of insects that attack man, animals and a variety of crops. Results are reported from studies on the influence of gamma radiation on the reproductive potential, sexual aggressiveness, vigor, and longevity of the oriental fruit fly, Dacus dorsalis (Hendel), melon fly, Dacus cucurbitae (Coq.), the Mediterranean fruit fly, Ceratitis capitata (Wied.), Mexican fruit fly, Anastrepha ludens (Loew), and Anopheles quadrimaculatus (Say) and results of practical field trials of the sterile male release method of population suppression. Progress in the campaign to eradicate the screw-worm, Cochliomyia hominivora (Cqrl.) in the United States and in studies to develop vigorous, genetically marked strains that will permit ready identifications of released sterile flies is reviewed. Results of irradiation research on 6 additional species which infest fruit, vegetable, field and forest crops, 3 which attack livestock, 3 which largely affect man, the effects of irradiation on the scorpion, Centruroides limpidus (Karsch), and the lone star tick, Amblyomma americanum (L.), and ionizing radiation as a possible quarantine treatment for fruits and vegetables infested with fruit flies and mangoes infested with the mango weevil, Sternochetus mangiferae (Fabricius), are also discussed. (auth)

20298 USE OF RADIOCOBALT IN EXPERIMENTS WITH CRYPTORRHYNCHUS LAPATHI L. (CURCULIONIDAE). C. Dafauce, D. Cadahia, and F. Astiaso (Ministry of Agriculture, Madrid). IAEA Preprint SM-40/40. 11p. (In Spanish)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

Three experiments with adults of Cryptorrhynchus lapathi L. were carried out using Co^{60} as tracer. In order to keep the radioactive material in contact with the insect an adhesive lacquer was added, which gave excellent results. The radioactive solution was applied to the rear part of the elytrons, the dose to each individual ranging from 50 to 150 μc. Detection was carried out by means of an Ekco N645A field ratemeter, equipped with an N674A scintillation counter having an N665A gamma head. The tagged insects were thus easily located in the field. In the first experiment, intended to study adult dispersion, 100 insects were used. After 80 days only 23 were located, losses being definitely due to predatory action, especially on the part of birds. Eighty-three per cent of individuals did not cover a distance greater than 30 m, and only 10% exceeded 50 m. In the second experiment, for the purpose of investigating the over-wintering habits of adults of C. lapathi L., 48 tagged individuals were used within a nylon-mesh cage, dimensions 3 × 9 × 3 m, covering a plantation of 24 black poplars, in order to avoid losses by predatory action. The first observation, carried out at the end of January, revealed the survival-rate for females to be significantly higher than that for males. The potential survival-rate for females is extremely high up to the present. The third experiment was conducted to test the effectiveness of dusting with 2% parathion as a measure to combat C. lapathi L. adults in the field, previous laboratory experiments having shown this to be the only effective insecticide. In July 50 tagged adults were released into a black poplar plantation, dusting being carried out 4 days later. At the end of 15 days only 15 individuals were located, the remainder having fallen victim to predators. It was also observed that the cellulose acetate adhesive employed on this occasion did not give satisfactory results. On 30 October the experiment was repeated in another poplar plantation, and between 4 and 10 days later a total of 24 adults were recovered, 11 of which died as a result of the treatment. On this occasion predatory action by birds was also proven. The effectiveness of radioisotopes in these studies on bioecology and on the determination of mortality rates in pest-control operations may be inferred. (auth)

20299 SOME PROBLEMS IN THE DETERMINATION OF RESIDUES IN PLANTS AND MAMMALS. D. F. Heath (Medical Research Council Labs., Carshalton, Eng.). IAEA Preprint SM-40/6. 18p. (In English)

To be published in Proceedings of the IAEA Symposium on the Use and Application of Radioisotopes and Radiation in the Control of Plant and Animal Insect Pests, Athens, Greece, April 22-26, 1963.

In most instances pesticide residues in plants and animals must be determined by chemical or biochemical methods without the use of radioisotopes. These methods assume that the nature of the toxic compounds present is known, and that they can be extracted in known yields. Neither assumption is easily validated except by using radioisotopes. The use of radioisotopes to investigate these problems is described with examples taken from work on demeton, dieldrin, and the fungicide triphenyltin acetate. (auth)

20300 IMPROVEMENTS IN OR RELATING TO IRRADIATION INSTALLATIONS. Pierre Vidal. British Patent 921,905. Mar. 27, 1963. Priority date June 10, 1958, France.

An irradiation installation is designed for treating crops, trees, and other plants on the ground. The installation comprises a radiation source supported above a well, means for rotating the source around on a vertical axis, means for lowering and raising the source into and out of the well, and shielding means for closing the well. A roof is provided for protection against bad weather. (D.L.C.)

20301 IMPROVEMENTS IN OR RELATING TO THE CURING OF RUBBER. Denis Newton Keyte (to Dunlop Rubber Co. Ltd.). British Patent 922,531. Apr. 3, 1963. Filed Dec. 30, 1958.

A process is given for the curing of natural rubber and butadiene/styrene rubber. The process comprises incorporating in the rubber 2.5 to 7% of an organic peroxide and exposing the composition of 3×10^6 to 5×10^7 rads of high-energy ionizing radiation. Five examples of the process are given. (D.L.C.)

20302 A PROCESS FOR IMPROVING THE PROPERTIES OF SYNTHETIC FIBRES, FABRICS, FILMS AND MOULDED ARTICLES BY THE IRRADIATION OF IONISING RAYS. (to Director of Kogyo-Gijutsu-In). British Patent 923,851. Apr. 18, 1963. Priority date Apr. 28, 1958, Japan.

A process is given for improving the dyeability and hygroscopicity of fibers, fabrics, films, and molded articles made from synthetic high polymers. The process comprises irradiating the polymeric products with 10^4 to 10^7 r in the presence of certain heterocyclic compounds having three atoms in the heterocyclic ring. Some of the heterocyclic compounds which may be used are ethylene oxide, ethylene sulfide, ethylene imine, epichlorhydrin, propylene oxide, etc. (D.L.C.)

20303 MOVING BED NUCLEAR REACTOR FOR PROCESS IRRADIATION. Henry J. Ogorzaly (to Esso Research and Engineering Co.). U. S. Patent 3,085,057. Apr. 9, 1963. Filed Dec. 23, 1957.

A reactor for the irradiation of liquid organic materials is designed which is based on the critical moderation of the fission reaction by the organic materials. In operation of the reactor, the liquid material is passed down through the bed of fissile solids and removed from the reactor bottom. The reactor is particularly suited for the conversion of aliphatic hydrocarbons into a distillate lubricant fraction. (D.L.C.)

INSTRUMENTS AND INSTRUMENTATION

General and Miscellaneous

Refer also to abstracts 20222, 20665, 20669, and 20683.

20304 (BRL-Memo-1448) TWO WAVELENGTH, STREAK INTERFEROMETRY OF AN IONIZED, HEAVY GAS. F. D. Bennett, H. S. Burden, and D. D. Shear (Ballistic Research Labs., Aberdeen Proving Ground, Md.). Jan. 1963. 17p.

The problem of measuring interferometrically both the mass density and the electron concentration in an ionized gas requires interferograms at 2 different wavelengths. Transient ionized gases can be examined by the method of streak interferometry. By inserting a dichroic mirror-divider and duplicate optical trains with appropriate filters, the basic streak interferometer can be modified to produce 2, simultaneous, streak interferograms at selected wavelengths. (auth)

20305 (CEA-2242) REALISATION D'UN APPAREIL DE MESURE DE LA CONDUCTIBILITE THERMIQUE DU GRAPHITE IRRADIE OU NON IRRADIE. (Development of an Apparatus for Measuring the Thermal Conductivity of Irradiated or Non-Irradiated Graphite). M. Bocquet and G. Micaud (France. Commissariat à l'Energie Atomique. Centre d'Etudes Nucléaires, Saclay). 1962. 22p.

An apparatus was developed for measuring the thermal conductivity coefficient K of irradiated or nonirradiated graphite. The measurement of K at around room temperature with an accuracy of about 6% is possible. The study specimen is placed in a vacuum between a hot and a cold source which create a temperature gradient $\Delta\Theta/\Delta x$ in the steady state. The amount of heat transferred, Q, is deduced from the electrical power dissipated at the hot source, after allowing for heat losses. The thermal conductivity coefficient is defined as: $K = Q/S \cdot \Delta x/\Delta\Theta$, S being the cross section of the sample. Systematic studies have made it possible to determine the mean values of the thermal conductivity. (auth)

20306 (ISS-63/10) DISPOSITIVO DI SICUREZZA PER UNA ULTRACENTRIFUGA ANALITICA. (Safety Devices for an Analytical Ultracentrifuge). C. Felici (Italy. Istituto Superiore di Sanità, Rome). Jan. 17, 1963. 13p.

Automatic safety devices for the Spinoco model E analytical ultracentrifuge are described. Emphasis is placed on preventing occurrences such as sudden leakage, cell window breakage, or speed control system damage having unsettling effects on the rotor or causing it to run away. (J.R.D.)

20307 (ISS-63/19) STUDIO DI ALCUNI TIPI DI GATES A TRANSISTORS. (Characteristics of Some Types of Transistor Gates). G. Arancia and G. Fronterotta (Italy. Istituto Superiore di Sanità, Rome). Jan. 30, 1963. 15p.

Three types of transistor gate circuits were studied and tested in order to find one that has a good linearity and rapidity and is without pedestal. The functioning of each of the three circuits is described and the results of the tests are presented. Finally these results are shortly discussed. (auth)

20308 (NBL-191) A VERSATILE SIX-INCH RADIUS MASS SPECTROMETER FOR ISOTOPIC ANALYSIS OF SOLIDS, LIQUIDS, OR GASES. H. O. Finley, R. J. Hemmer, and L. C. Nelson, Jr. (New Brunswick Lab., AEC, N. J.). Apr. 1963. 38p.

A six-inch radius mass spectrometer was constructed for isotopic analysis requiring a minimum of instrumentation and personnel. The instrument is a six-inch radius, 60° sector-shaped analyzer. Its primary intended use is for low-mass work for boron and lithium analysis, as well as for comparison studies in the isotopic measurement of uranium. The work for high-mass gas samples is limited by the small radius, although the need for a dual collection ratio gas instrument is essential for comparison purposes. The instrument is designed for the analysis of a wide variety of elements by a number of different methods with minimum change in instrument geometry and source systems. A magnet current regulator designed to regulate from 0 to 550 milliamperes is used in conjunction with an accelerating voltage supply of 5000 volts which permits the isotopic analysis in a M/e range of 300 mass units. This combination permits a wide selection of ion energies resulting in excellent peak shapes and resolutions. Special vibrating reed electrometers or electron multiplier counting-type measuring systems are designed into the instrument, along with a dual collection and ratio precision potentiometer, decade-type measuring device. (auth)

20309 (TID-18271) DEVELOPMENT OF A HIGH SPEED PHOTOMULTIPLIER. Progress Report, October 2, 1962–January 2, 1963. W. Wade Sapp (Westinghouse Electric Corp. Electronic Tube Div., Elmira, N. Y.). Contract AT(30-1)-2825. 40p.

A total of eight operable tubes of varying design were constructed. Two of these, which are indicative of the present state of the art, are ready for delivery. These tubes have electron gains of better than 8×10^5 for dark currents less than 5×10^{-9} amperes. (Cathode at negative high voltage.) Ag–MgO mesh processing and fabrication studies advanced the state of the art to the point that stage gains in excess of 3 are readily obtained for uncesiated dynodes. Pulse rise time of these dynodes was investigated and was found to be $\sim 1.6 \times 10^{-9}$ seconds per stage. (auth)

20310 (TID-18485) A PROGRAMMED KERR CELL FRAMING CAMERA. Sumner Ackerman (Edgerton, Germeshausen and Grier, Inc., Boston). Apr. 1963. Contract [AT(29-1)-1183]. 19p.

A new high-speed framing camera is described, using a single programmed Kerr cell shutter coupled to a wide field rotating drum streak camera having a potential maximum writing speed of 12,000 in./sec and an effective relative aperture of f15. The experimental Programmed Kerr Cell Camera can take up to 100 discreet exposures of 10^{-7} to 5×10^{-7} sec duration at framing rates greater than 500,000 fps. This camera system has particular advantages when the object dimensions change with time or when its aspect ratio is not unity, in which cases the writing speed of the camera may be more efficiently used than with more conventional framing cameras. Since exposure time is independent of framing rate it is also of special usefulness when relatively slow framing rates must be accompanied by very fast exposure times. Frame timing can be known to a precision in the order of nanoseconds; it is easy to correlate this timing with electrical phenomena associated with the event being photographed by means of oscillo-

graphic records. A number of subjects were photographed with the experimental PKCC to determine and demonstrate its capabilities. An overall resolving power of better than 45 line pairs/mm was measured at film speeds up to 5,000 in./sec and it is expected that a resolution of at least 30 line pairs/mm will be realized at a maximum film speed of 12,000 in./sec. (auth)

20311 (TRG-Report-469) A BASIC TRAINING SCHEME. PART I. CALIBRATION AND ADJUSTMENT OF PNEUMATIC INDICATORS: NOTES. R. A. Chapman (United Kingdom Atomic Energy Authority. Reactor Group, Dounreay, Caithness, Scotland). Jan. 16, 1963. 52p.

A course was prepared to provide basic training in the primary features of instrumentation. The purpose of this course is to prepare apprentices, at an early stage in their training, to receive on site the traditional instruction given by craftsmen. The staff required to run this course consists of a technician who gives lectures on theory supported by a craftsman chosen for his practical knowledge of the work. The course is grouped into projects, and each project is based on an operation which may be encountered daily by an instrument craftsman. Notes for the guidance of the instructor are given; and safety, craft, and theory aspects are covered together with model answers to the problems posed in the first group of ten projects. (auth)

20312 (UCRL-10631) DESIGN OF A DIFFERENTIAL CALORIMETER SUITABLE FOR MEASUREMENT OF HIGH TEMPERATURE HEATS OF SOLID STATE REACTIONS (thesis). John O. Barner (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 29, 1963. Contract W-7405-eng-48. 49p.

A differential calorimeter suitable for measurement of high-temperature heats of solid state transformations was designed and tested. The heats of transformation of SiO_2, K_2SO_4, Na_2SO_4-III, and FeS were measured and were found to be in general agreement with published values. Increase in heat content measurements were found to be 30 to 40% high owing to unequal vertical heat losses from the two sample cells of the differential calorimeter. Recommendations for further studies are made. (auth)

20313 (AEC-tr-5764) THE PRODUCTION OF HIGH INTENSITY X-RAY SPECTRA WITH THE HELP OF CONCAVE CRYSTALS. H. H. Johann. Translated for Ames Lab., Ames, Iowa from Z. Physik, 69: 185-206(1931). 20p.

That sharp spectra can be produced by Bragg reflection from the concave side of an unsplit, cylindrically turned crystal is shown both mathematically and geometrically. The special sources of error inherent in the method are discussed, comparing its intensities with those of other methods. Further, a spectrograph built according to these principles is described. Several of the spectra obtained are reproduced. Potential uses of the method are discussed. (auth)

20314 PHOTOMULTIPLIERS IN EXPERIMENTAL PHYSICS— PROBLEMS ENCOUNTERED IN DESIGN, PRODUCTION, AND USE. G. Pietri (Laboratoires d'Électronique et de Physique Appliquée, Paris). Acta Electronica, 5: 7-30(Jan. 1961). (In French)

One of the purposes for which photomultipliers are used is to determine with accuracy the instant of occurrence of luminous phenomena. This application is examined, and possible methods are discussed. The operating principles of the photomultiplier are outlined, leading to examination of the problems encountered in the production of these tubes and their operational limits. The components of a typical photomultiplier are described, with the conditions that they must fulfill for optimum efficiency. In this analysis, the points of view of both the user and the maker are considered. A discussion of development tendencies and calculation of the response of the electron optical system of photomultipliers in pulsed operation are given. (auth)

20315 SERIES PRODUCTION OF PHOTOMULTIPLIERS (TECHNOLOGY AND TESTING PROCEDURES). E. Morilleau (La Radiotechnique, Brive, France). Acta Electronica, 5: 39-51(Jan. 1961). (In French)

Technology (choice of materials, photocathode activation, multiplier design) is of importance in the series production of photomultipliers. The examination of technological problems is followed by the discussion of typical test procedures in product quality inspection (sensitivity and uniform composition of the photocathode, anode sensitivity, energetic resolution, electron transit time). Statistical curves are given to trace progress in the last three years. (auth)

20316 SOME CONSIDERATIONS CONCERNING THE PERFORMANCES OF FAST RESPONSE PHOTOMULTIPLIERS. C. Cernigoi, I. Gabrielli, and G. Iernetti (Université, Trieste, Italy). Acta Electronica, 5: 53-60(Jan. 1961). (In French)

The criteria for the determination of photomultiplier response are restated, and experimental methods for the study of the output pulses of these tubes are briefly described. The results obtained with four types of fast response photomultipliers are used for the comparison of performances and as a guide in the choice of tube according to the application considered. (auth)

20317 PULSE HEIGHT VARIATIONS IN A FAST RESPONSE PHOTOMULTIPLIER. P. Raimbault (Centre d'Études Nucléaires, Saclay, France). Acta Electronica, 5: 61-72(Jan. 1961). (In French)

The pulse-height variations in a fast-response photomultiplier are studied by injecting two independent random variables which determine the form of the anode pulses. The energy of each pulse, directly dependent on gain and its variance, is the first variable; pulse heights varying according to this variable are further dependent on pulse width, which is the second variable. The results obtained in peak pulse amplitude variation with a fast pulse widening circuit, and those bearing on the statistical variations of gain, are compared to demonstrate that the relative variance of peak pulse amplitude is greater than that of gain. In the above measurements, the effects of the secondary emission coefficient of the first dynode and those of the average secondary emission coefficient of the multiplier are shown. (auth)

20318 HIGH INTENSITY NEUTRON DIFFRACTOMETER. P. Szabó, E. Krén, and J. Gordon (Central Research Inst. of Physics, Budapest). Acta Phys. Acad. Sci. Hung., 15: 203-13(1963). (In English)

Design and characteristics of a high intensity neutron diffractometer are described. The suitability of the method of single crystal growing and orientation is proven by single crystal measurements. Diffraction measurements on crystals of known structure and properties, and comparison between measured and calculated intensities, as well as angles of reflection give a favorable account of the intensity, resolving power, and accuracy to be obtained with the equipment described. (auth)

20319 BEAM CURRENT MEASURING DEVICE FOR ION ENGINE RESEARCH. Stanley Domitz and Eugene V. Pawlik (Lewis Space Center, Cleveland). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 712-13(Mar. 1963).

The magnetic ammeter that detects the magnetic field created by the flow of charged particles measures net direct-current at any position along an ion beam. Information is presented on the feasibility of producing a much larger instrument for use in ion engine research. (C.E.S.)

20320 SCANNING CIRCUITS FOR MASS SPECTROMETERS. J. Schutten and T. Van Der Hauw (F.O.M. Laboratorium voor Massascheiding, Amsterdam). Appl. Sci. Res., Sect. B, 9: 393-402(1963).

A description is given of a number of circuits for scanning a mass spectrum in a magnetic field type mass spectrometer. Linearization of the mass-scale on the recorder producing the mass spectrum is described for scanning both the magnetic and the electric field. Some time-saving circuits are given. (auth)

20321 STUDY, CONSTRUCTION, AND PERFORMANCES OF A LOGARITHMIC AMPLIFIER WITH ELECTROMETRIC TUBE FITTED AS MEASUREMENT DIODE. M. Rival. Bull. Inform. Sci. Tech. (Paris), No. 64, 18-28 (Aug.-Sept. 1962). (In French)

The different systems used for the logarithmic measurement of currents are compared. Three types of systems are considered: use of the cathode grid space of the entry tube, use of a measurement diode, and use of an electrometric tube fitted as measurement diode. The electrometric tube that is used for measuring currents below 10^{-7} amp is studied in detail. (auth)

20322 TESTS OF NEW FAST PHOTOMULTIPLIERS. J. Oostens. Bull. Inform. Sci. Tech. (Paris), No. 64, 29-36(Aug.-Sept. 1962). (In French)

A photomultiplier equipped with a coaxial output should be capable of transmitting faster pulses than one not so equipped. The measurement of the rise time of the output pulse of a coaxial photomultiplier is described. The very fast flash ($<10^{-10}$ sec) of a mercury relay is used, and the resulting output pulse is photographically recorded on a progressive wave oscilloscope. The rise time, which is 2.3 mμsec (nanoseconds) with a 56 AVP photomultiplier tube, falls to 1.7 with the new tube, and the pulse is shorter. The coincidence curve between the relay flash and the photomultiplier output is 0.16 nsec wide. This photomultiplier is used in time-of-flight applications in a secondary beam of the Saturne synchrotron. (auth)

20323 ION IMPLANTS FORGE TAILOR-MADE JUNCTIONS. Thomas Maguire. Electronics, 36: 26-7; 29 (Apr. 19, 1963).

The technique of ion implantation by bombardment is now in the research and development stage. Solar cells have been made with this technique, and it is hoped to make a cell with high radiation resistance. The apparatus for carrying out the technique is described briefly. (D.L.C.)

20324 POINT CONTACT DIODES UTILIZING SINGLE-CRYSTAL REDUCED RUTILE TITANIUM DIOXIDE. Goebel Davis, Jr. and W. W. Grannemann (Univ. of New Mexico, Albuquerque). J. Appl. Phys., 34: 228-30(Jan. 1963). (SCR-578)

Point contact diodes were made by utilizing reduced single-crystal rutile TiO_2. No indication of minority carrier holes injection was experimentally detectable. The diode volt-ampere characteristics were fitted to different theoretical mathematical models of diode operation for noninjecting contacts. The resultant fits indicate (for both diode and diffusion theory) that the rectification phenomena are most likely attributable to a Mott-type barrier in which the image forces reduce the effective barrier height in the reverse direction. (auth)

20325 AN ION BOMBARDMENT APPARATUS WITH A HIGH FREQUENCY ION SOURCE. B. Navinšek, F. Požar, and V. Marinković (Nuclear Institute "J. Stefan," Ljubljana, Yugoslavia). J. Sci. Instr., 40: 201-2(Apr. 1963).

A description of an ion bombardment unit is given. Ions at 3 to 15 kev are supplied by a high-frequency source with post-acceleration. The object chamber can accommodate up to twelve specimens at a time, and a low power microscope is provided for the observation of the specimen changes during the bombardment. (auth)

20326 PROGRESS IN X-RAY PHYSICS. Gyoergy Orbán. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 143-67(Dec. 1962). (In Hungarian)

Instruments for the generation of electrons and x rays are described for use in medicine and in industry. The principles of operation of the x-ray image amplifier are explained. Snapshot radiographs and x-ray-diffraction radiographs are included. Investigation of the polarization of primary x rays, the intensity distribution of scattered radiation around a plexi scatter-cone, and the spectral distribution of the polarization are discussed. (C.E.S.)

20327 DYNAMIC rf PHASE METER. H. Hahn and R. J. Orgass (Brookhaven National Lab., Upton, N. Y.). Rev. Sci. Instr., 34: 406-8(Apr. 1963).

A transistorized phase meter built around a NOR circuit is described. The upper frequency limit is on the order of 4.5 Mc. The use of a flip-flop as a frequency divider extends the usable phase range from 0 to 360°. The resulting ambiguity is corrected by a reset circuit. The deviation from linearity is less than ±1°. The phase modulation frequency bandwidth is 20 kc. (auth)

20328 SIMPLIFIED SYSTEM FOR THE MEASUREMENT OF FLUORESCENCE LIFETIMES USING THE STROBOSCOPIC METHOD. G. C. Brown, Jr. (Johns Hopkins Univ., Baltimore. Rev. Sci. Instr., 34: 414-15(Apr. 1963).

A simplified and convenient technique for the electronic instrumentation of a stroboscopic system for the measurement of fluorescence lifetimes is described. A modified Tektronix 545 A oscilloscope obtains all the necessary triggers for such a system including a delayed trigger of continuously variable delay. The display of the integrated fluorescence signal is such that the decay time is obtained directly from the calibrated time bases of the oscilloscope. (auth)

20329 CIRCUIT FOR THE DISPLAY OF LANGMUIR PROBE CHARACTERISTICS. R. S. Harp (Stanford Univ., Calif.). Rev. Sci. Instr., 34: 416-20(Apr. 1963).

The use of Langmuir probes for plasma measurements usually entails laborious graphical reduction of data to obtain the electron temperature, and errors are often introduced by drift in the plasma characteristics while the measurements are being taken. A simple and accurate electronic device is described for reducing the probe data and displaying the results on an oscilloscope. The circuit employs commercially available plug-in amplifiers to provide maximum ease of construction, and high accuracy is obtained with a minimum of calibration adjustments. (auth)

20330 TIME-OF-FLIGHT METHOD OF DETERMINING VELOCITIES OF SPUTTERED ATOMS. R. V. Stuart, K. Brower, and W. Mayer (General Mills, Inc., Minneapolis). Rev. Sci. Instr., 34: 425-9(Apr. 1963).

A method is described whereby velocities of sputtered atoms are determined by pulsing a target and measuring the transit time of sputtered atoms. The method permits

determination of the distribution of velocities of sputtered atoms. The target pulse generator and the problems involved in pulsing a target are discussed. The photon-counting system used for determining transit times is described and a typical set of data is presented. (auth)

20331 SIMPLIFIED OBSERVATION OF PHOTOMULTIPLIER PULSES WITH A SAMPLING OSCILLOSCOPE. Wayne L. Long (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 430(Apr. 1963).

A simple technique is described for observing random pulses without special circuitry. The trigger sensitivity can be set so that only the largest pulses trigger the internal sweep. When the sensitivity is increased, more of the pulse-height spectrum is shown. (D.L.C.)

20332 MINIATURE SAMPLE ORIENTING DEVICE FOR USE AT LOW TEMPERATURES AND HIGH MAGNETIC FIELDS. A. C. Thorsen and T. G. Berlincourt (Atomics International, Canoga Park, Calif.). Rev. Sci. Instr., 34: 435-6(Apr. 1963).

A sample orienting device was designed for pulsed magnetic field studies of the de Haas-van Alphen effect in crystals. The device may be calibrated at room temperature and then used at liquid helium temperature in a Dewar without recalibration. (D.L.C.)

20333 THE DIRECT CURRENT BREAKING SPARK AS NEW ION SOURCE FOR MASS SPECTROSCOPIC INVESTIGATIONS OF SOLID BODIES. K. D. Schuy and H. Hintenberger (Max-Planck-Institut für Chemie, Mainz). Z. Naturforsch., 18a: 95-7(Jan. 1963). (In German)

Experiments with direct current breaking sparks for ion production in solid substances are reported. With that mass spectra could be obtained with the help of high-frequency sparks. Its design is described and advantages discussed. (M.C.G.)

20334 PRECISION PRISMATIC BETA-SPECTROMETER. I. ELECTRON OPTIC SCHEME AND CONSTRUCTION. V. M. Kelman, B. P. Peregood, and V. I. Skopina (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 32: 1446-64(Dec. 1962). (In Russian)

Descriptions are given of a high resolving power, high aperture ratio magnetic β spectrometer measuring of radioisotope electron spectra. The electron-optical system is similar to the optical spectrometer scheme and has a high-range solid-angle variability. The deflecting magnet gap field is stabilized with a precision of 0.003%. The magnitude varies within the limits of the corresponding electron energies (from 30 to 2800 kev). The spectrometer operation is completely automatic. The background level is reduced to 5 pulses per hour. (tr-auth)

20335 PRECISION PRISMATIC BETA-SPECTROMETER. II. RESOLVING POWER, SOLID ANGLE AND ACCURACY OF MEASURING ENERGY. V. M. Kelman, B. P. Peregood, and V. I. Skopina (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 32: 1465-76(Dec. 1962). (In Russian)

The characteristics of a magnetic β spectrometer are analyzed. It is shown that the resolving power of the spectrometer changes from 0.014 to 0.18% with solid angle variations from 0.005 to 0.8%. The half-width of the conversion lines is not a function of energy. The precision for energy determination is 0.02% and for conversion line relative intensities, 2 to 3%. (tr-auth)

20336 NUCLEAR ELECTRONIC INSTRUMENTS IN TROPICAL COUNTRIES. Technical Reports Series No. 13. Vienna, International Atomic Energy Agency, 1963. 31p. $1.00; Sch 21; NF 4; DM 3.20. (IAEA). (STI/DOC/10/13)

A guide is presented which gives the specifications for the ordering of nuclear electronic instruments to be used in tropical countries. (D.L.C.)

20337 IMPROVEMENTS RELATING TO THE MEASUREMENT OF DENSITY OF FLUIDS WITHIN A PIPE OR THE LIKE. Douglas Francis White (to E. K. Cole Ltd.). British Patent 923,630. Apr. 18, 1963. Filed Dec. 22, 1960.

A gamma-scattering method and apparatus are described for measuring the density of a gaseous fluid in a pipe. The method comprises directing a collimated beam of high-energy gamma rays diametrically across the pipe and selectively sampling the scatter with a detector outside the pipe. The selective sampling is performed by a pulse-height selector which selects only those pulses corresponding to predetermined energy levels. (D.L.C.)

20338 IMPROVED APPARATUS FOR PRODUCING BREMSSTRAHLUNG RADIATION. Neil Edward Handel (to Industrial Nucleonics Corp.). British Patent 923,989. Apr. 18, 1963. Filed July 28, 1961.

A source for producing pure bremsstrahlung is designed for use with a thickness-measuring gage. The source comprises a radioisotope emitting both beta rays and gamma rays and a target disposed in the path of the emitted rays and inclined with respect to the path. The target should be of a thickness sufficient to absorb most of the beta rays to produce bremsstrahlung while passing most of the gamma rays, e.g., 0.050-in.-thick aluminum. The radiation detector for using this bremsstrahlung to measure thickness is disposed in the path of the bremsstrahlung but outside the path of transmitted gamma rays. (D.L.C.)

20339 MASS SPECTROMETER. Anton Martin Klopfer (to North American Philips Co., Inc.). U. S. Patent 3,086,110. Apr. 16, 1963. Priority date Mar. 15, 1958, Germany.

A mass spectrometer of the omegatron type, in which a beam of electrons is shot into a magnetic field and an h-f electric field, is designed with means for improved reproducibility of measurements. The means comprise two parallel plates arranged parallel to the magnetic field and having an applied negative voltage with respect to the h-f plates so that the flow of ions toward the collector is a maximum for both light and heavy ions. (D.L.C.)

20340 MASS SPECTROMETER FOR GASES AT LOW PRESSURES. Jan Peper (to North American Philips Co., Inc.). U. S. Patent 3,086,111. Apr. 16, 1963. Priority date May 19, 1959, Netherlands.

A mass spectrometer of the omegatron type is designed for improved sensitivity and resolving power. The omegatron chamber in which the gas to be examined is ionized by an electron beam is bounded by electrodes whose boundaries form the lines of intersection of planes with a surface of revolution of two conjugate hyperbolas. The axis of revolution coincides with the electron beam axis, and the asymptotes to the hyperbolas are at an angle to the revolution axis whose tangent is $\sqrt{2}$. (D.L.C.)

20341 CORPUSCULAR RADIATION APPARATUS. Wolfgang Dieter Riecke (to Max-Planck-Gesellschaft Zur Foerderung der Wissenschaften E. V.). U. S. Patent 3,086,112. Apr. 16, 1963. Priority date July 24, 1959, Germany.

An adjusting specimen table is designed for electron microscopes and diffraction devices. The table is a combination of a specimen carrier, a Cardan arrangement for

moving the carrier about any of three intersecting axes, and means for moving the carrier along an axis intersecting the Cardan intersection point. (D.L.C.)

20342 ELECTRON MICROSCOPE DIAPHRAGM ARRANGEMENT WITH AUXILIARY DEVICE FOR X-RAY SPECTROSCOPY OF IRRADIATED SPECIMEN. Karl-Heinz Herrmann (to Siemens and Halske Aktiengesellschaft). U. S. Patent 3,086,114. Apr. 16, 1963. Priority date May 26, 1959, Germany.

An auxiliary diaphragm for an electron microscope is designed for facilitating x-ray spectroscopy of the specimen. The aperture size of the auxiliary diaphragm is intermediate between those of the condenser and specimen diaphragms and is inserted between the two diaphragms in such a way that the scattered electrons from the condenser diaphragm are kept away from the rim of the specimen diaphragm. (D.L.C.)

Radiation Detection

Refer also to abstracts 21113, 21115, 21116, 21119, and 21315.

20343 (CEA-2236) UTILISATION D'UN COMPTEUR PROPORTIONNEL A GRANDE SURFACE POUR LA MESURE DES FAIBLES ACTIVITIES. (Use of a Large Surface Proportional Counter for Measuring Low Activities). P. Amardeil and R. Gonnard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Grenoble). 1962. 15p.

A proportional counter having a large surface (150 cm^2) is used at the Grenoble Nuclear Studies Center for the low-activity measurements made in controlling the site. This apparatus makes it possible to count directly high surface area filters (Dapaf filters for the study of the artificial radioactivity of air) and to monitor small river and rainwater samples. (auth)

20344 (CEA-2251) DOSIMETRIE ET SPECTROMETRIE DES NEUTRONS RAPIDES PAR RADIOACTIVATION. (Fast Neutron Dosimetry and Spectrometry Using Radioactivation). Jacques Lamerieux (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 61p.

A review of general information concerning induced radioactivity detectors is presented along with tables summarizing the properties of detector elements which may be used in radioprotection. The excitation functions found in the literature are also given. The technological characteristics of the detectors used are given, together with the counting methods. The many advantages of activation dosimetry for strong or periodic neutron fluxes and for those in the presence of γ-radiation are stressed. The main problem in activation dosimetry is, however, the calculation of the dose absorbed from the results of the measurements. It is shown how the dose is expressed, fairly accurately, as a function of the radioactivities induced in a series of detectors. As an example, the spectrometry and the dosimetry of the neutron flux emitted by a Po–Be source are presented. (auth)

20345 (DP-792) EVALUATION OF A PERMEABILITY CELL. Albert E. Symonds, Jr. (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). Jan. 1963. Contract AT(07-2)-1. 14p.

A permeability cell incorporating an ionization chamber was designed. This instrument was used to measure the permeation of plastic films by tritiated water vapor. (auth)

20346 (DPSPU-63-30-9) CALIBRATION OF RADIATION MONITORING INSTRUMENTS. D. B. Zippler (Du Pont de Nemours (E. I.) & Co. Savannah River Plant, Aiken, S. C.). Apr. 1963. Contract AT(07-2)-1. 13p.

Radiation-monitoring instruments are regularly calibrated to assure radiological protection of employees at the Savannah River Plant. Radiation sources used to calibrate about 1300 portable instruments include 30 curies Co^{60}, 10 curies Pu^{239}-Be, and 250 kvp x ray. A separate building for this extensive calibration program houses specifically designed equipment with which 21,000 calibrations per year can be performed promptly and safely. (auth)

20347 (ISS-63/26) A CURVED ACOUSTIC SPARK CHAMBER. U. Amaldi, Jr. (Italy. Istituto Superiore di Sanità, Rome). Mar. 25, 1963. 22p.

A cylindrical spark chamber with a useful opening angle of 130° and a radius of 55 cm is described. The angular position of a spark in a gap is determined by measuring the time of flight of the sound from the spark to two acoustic probes of the solid dielectric type. The maximum error in such a determination is about 0.5° (relative error ≤0.5%). (auth)

20348 (JÜL-90-ST) THE DETERMINATION OF THE AVERAGE ENERGY OF A FAST NEUTRON FLUX WITH PORTABLE NEUTRON SURVEY INSTRUMENTS. D. Nachtigall (Kernforschungsanlage, Jülich, Germany). Dec. 1962. 13p.

Several techniques used to determine the average neutron energy of the spectral distribution for neutron dose measurements are discussed. Operation of a small instrument that uses a double cadmium technique is particularly described, and experimental values obtained with it are given. (D.C.W.)

20349 (NAA-SR-Memo-4365) FAST NEUTRON FLUX MEASUREMENTS FOR SHIELDING APPLICATIONS. M. Roy (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Aug. 27, 1959. Contract [AT(11-1)-Gen-8]. 5p.

Pressed sulfur pellets, irradiated for two hours at 10 w yielded satisfactory counting rates on an internal proportional counter for measuring fast neutrons. The pellets were counted in their original form and an equation applicable to thick sources was applied to obtain disintegration rates. Decay data and beta energy analyses indicated that the induced activity was due to P^{32}. Cross section values reported in the literature for the $S^{32}(n,p)P^{32}$ reaction involved were found to differ widely. The fast flux values given are based on an assumed cross section of 285 millibarns in a fission spectrum. Thermal flux values at the same positions and for the same power are also presented. (auth)

20350 (ORO-490) THE APPLICATION OF PHOTOSENSITIVE GAS COUNTERS TO SCINTILLATION COUNTING. Final Report. R. L. Ely, Jr. and Lewis F. Ballard (Research Triangle Inst., Durham, N. C.). Mar. 31, 1962. Contract AT(40-1)-2513. 28p.

It is noted that a photocathode having a response matching that of p-terphenyl (without wave shifter) and a sharp cut-off around 4000 Å at the long wavelength end would be expected to exhibit less thermal noise since the work function of the photocathode would have been increased. At the same time, no loss of counting efficiency would be expected since the emission would match the photocathode response. Work in this area to determine whether the Cs–Sb photosurface used on commercial photomultipliers can be

modified to provide better wavelength matching is reported. Efforts toward removal of the long-wavelength tail so that thermal background is reduced are described. Results of the investigation indicate that there are complicating factors which interfere with the use of the photosurface in commercial tubes such as the 6292 (S-11), as a Geiger cathode. One is that the high electrical resistivity of the film results in a low pulse height (≈10 mv), thus affecting the descriminator. A second effect is the short plateau terminating in an abrupt and large increase in upper-end counting. Approaches to overcoming these faults were not found; however, it is felt that the concept deserves further research. (J.R.D.)

20351 TIME-AMPLITUDE CONVERTER. M. Banner (Centre d'Études Nucléaires, Saclay, France). Acta Electronica, 5: 73-88(Jan. 1961). (In French)

To determine the mass of a particle, the common practice in high-energy physics is to measure its transit time. This measurement is not very simple, for it is easier to analyze an amplitude than a time. Thus, a time-amplitude converter was designed and is described. The converter uses a double control grid tube 6BN6 with a resolving time of 5×10^{-11} sec, as measured with a pulse generator. Analysis of the response of a particle detector, consisting of a scintillator and a photomultiplier, shows that a resolving time of 5×10^{-10} sec can be attained. A time of this magnitude was in fact experimentally achieved. The converter described was used to study the transit time of particles in a secondary beam in the accelerator "Saturne". The energy spectra of π mesons, protons, and deuterons, emitted by a polyethylene target under 1.4 and 2 Bev proton bombardment, were measured by this method. (auth)

20352 NEW VSRT SCINTILLATION COUNTERS (VERY SHORT RESOLVING TIME). Lydie Koch (Centre d'Études Nucléaires, Saclay, France). Acta Electronica, 5: 103-10 (Jan. 1961). (In French)

Rare gases used as scintillators have a characteristically short scintillation and linearity of response versus total transferred incident-particle energy. Associated with fast-response photomultipliers, these scintillators make it possible to solve certain problems in nuclear physics, in which a linear detector with a very short resolving time (a few nanoseconds) is an indispensable requirement. Two typical units, the results obtained, and future possibilities are described. (auth)

20353 INVESTIGATIONS OF THE VACUUM NEED OF β-SPECTROSCOPES. Z. Bödy and D. Berényi (Bereni) (Inst. of Nuclear Research, Hungarian Academy of Sciences, Debrecen). Acta Phys. Acad. Sci. Hung., 15: 215-33(1963). (In English)

The vacuum dependence of transmission and resolving power for β spectroscopes was theoretically investigated. For the vacuum dependence of both transmission and resolving power analytic formulas were obtained. These were in good agreement with experimental data obtained by a β spectrometer of the toroid-sector type. (auth)

20354 THE RESPONSE OF PHOTOGRAPHIC MATERIALS TO IONIZING RADIATIONS. R. H. Herz (Kodak Ltd., Harrow, Eng.). Appl. Mater. Res., 2: 12-19(Jan. 1963).

A discussion is presented of the basic principles of the action of ionizing radiations in photographic materials. The mechanism of latent image formation in grains is considered, and current views of the mechanism are criticized. The response of the emulsion layer as a whole is also considered. Other items discussed are graininess, quantum efficiency, spectral sensitivity, reciprocity rule, and characteristic curves. (D.L.C.)

20355 INVESTIGATION OF SHALLOW ARTIFICIAL SCINTILLATORS AND TREATMENT OF IMPULSES FOR MEASUREMENTS OF COSMIC RADIATION. K. P. Beuermann and G. Wibberenz (Universität, Kiel). Atomkernenergie, 8: 90-4(Mar. 1963). (In German)

Preparatory studies are described for the design of a range spectrometer to be used for investigations of cosmic radiation. Pulse-height distributions were measured for shallow scintillators, using various optical and geometrical arrangements. The results are compared with the Landau theory. It turned out to be better to apply the photomultiplier directly to the scintillator than to use light guides. The preamplifier used is suitable to register two decades of pulse heights on the oscilloscope without employing a logarithmic amplifier. (auth)

20356 RESPONSE CAPACITY OF CORONA-SPARK COUNTERS. A. Rahn (Universität, Giessen, Ger.). Atomkernenergie, 8: 94-8(Mar. 1963). (In German)

A specific response capacity is defined by introducing the term "effective counter wire length." This is followed by an investigation of those parameters with which the response capacity to α particles changes with particular strength. The absolute measurements performed subsequently yield the figure 0.7×10^{-3} per cm "effective counter wire length" for the specific response capacity in air, under normal pressure, and 0.5×10^{-6} per cm "effective counter wire length" for fast neutrons. It is true that greater response capacities are obtained with other detection methods but in mixed radiation fields, there is the difficulty of differentiating between the radiation types. The spark counter, on the other hand, makes it possible to differentiate between strongly and weakly ionizing particles, such as α particles or neutrons (by way of production of scatter particles) on a background of β or γ radiation. (auth)

20357 NUCLEAR INSTRUMENTATION. No. 13. Bull. Inform. Sci. Tech. (Paris), No. 65, Suppl. No. 13, 1-35(Oct. 1962). (In French)

The standardized testing program for linear amplifiers used for the measurement of low d-c currents is described. The design and characteristics of newly developed detectors, power supplies, detection instruments, pulse generators, monitoring devices, and cathode tubes are given. (J.S.R.)

20358 CLASSIFICATION OF ACTIVITIES OF MATERIALS AND REAGENTS. B. Grinberg and Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 65, 6-8(Oct. 1962). (In French)

The classification system used to express the contamination of solids or liquids is briefly described. The utilization of this system in the selection of materials for measurement devices is illustrated. (J.S.R.)

20359 DETECTION THRESHOLD, MEASUREMENT THRESHOLD, AND FACTOR OF MERIT OF MEASUREMENT DEVICES. B. Grinberg and Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 65, 20-3(Oct. 1962). (In French)

In the region of microactivities, as in the region of high activities, there is no single universal measurement device that is superior to all others. The objective criteria used in the selection of a detector for a given problem—detection threshold, measurement threshold, and factor of merit—are summarized briefly and reviewed. (J.S.R.)

20360 MEASUREMENT TECHNIQUES FOR BETA ACTIVITIES. Y. Le Gallic. Bull. Inform. Sci. Tech. (Paris), No. 65, 24-35(Oct. 1962). (In French)

The optimum conditions for the detection of micro beta activities were determined for a solid and a liquid source. The superiority of 3π counters for solids and for liquids with maximum β energy above 0.6 Mev is shown. Liquid scintillators are preferred for solutions with maximum β energy below 0.6 Mev. (J.S.R.)

20361 TECHNIQUES FOR THE MEASUREMENT AND ANALYSIS OF GAMMA RADIATION. J. Legrand. Bull. Inform. Sci. Tech. (Paris), No. 65, 36-48(Oct. 1962). (In French)

The most appropriate techniques and the optimum conditions for the detection and analysis of gamma radiation at low levels are defined. Selection of detector, shielding, associated electronics, and optimum experimental conditions are discussed. (J.S.R.)

20362 CALCULATION OF A CORRELATION FUNCTION FOR THE STUDY OF THE DEAD TIME OF A DETECTOR. Gilbert Landaud (Université, Caen, France). Compt. Rend., 256: 1733-5(Feb. 18, 1963). (In French)

In order to measure the dead time of a particle detector, a correlation function associated with detection pulses was studied. The dead time effectively associated with an experiment can thus be defined without preliminary measurements. (tr-auth)

20363 RADIOSONDE MEASURES AFTER-EFFECTS OF SOLAR EVENTS. E. Waibel (Max-Planck-Institut für Aeronomie, Lindau, Ger.). Electronics, 36: 47-51(Apr. 19, 1963).

A balloon-borne radiosonde was developed for exploring phenomena initiated by solar events in the auroral zone. The radiosonde uses both a scintillation counter and a counter telescope and can distinguish between photons and charged particles. (D.L.C.)

20364 APPLICATION OF NITROUS OXIDE FOR CHEMICAL DOSIMETRY. T. Takatani. Genshiryoku Kōgyō, 9: No. 2, 60-4(Feb. 1963). (In Japanese)

The possibility of using nitrous oxide for the chemical dosimetry of γ-radiation was investigated for the purpose of determining the range of the dose measurement and the effect of the dose rate on the material. The experiments were carried out by exposing the nitrous oxide, sealed in a glass tube to the γ-radiation of a Co^{60} source, using a thermistor for determining the decomposition products, O + N. No rate dependence could be established in the dose range from 8.4×10^3 to 1.4×10^6 r/hr; neither was it possible to find a temperature dependence within 0 to 50°C. On the other hand, it was found that the method makes it possible to measure very large doses with an error less than 10%. (TTT)

20365 MEASUREMENT OF GAMMA RADIATION BY A THERMOLUMINESCENT DOSIMETER. János Félszerfalvi and József Patkó. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 169-76(Dec. 1962). (In Hungarian)

For uses in radiotherapeutical dosimetry, a very small-size thermoluminescent dosimeter was devised, composed of $CaSO_4$:Mn crystals. A very simple and handy evaluation equipment was constructed employing the existing nuclear instrument range. According to measurements, the intensity of the emitted thermoluminescent light is proportional over a wide range, between 10 and 1500 rads, to the absorbed dose. In addition, parameters of the micro-crystals were determined. (auth)

20366 INVESTIGATIONS ON THE TECHNIQUE OF SCINTILLATION β-SPECTROSCOPY. Dénes Berényi and Béla Bíró. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 183-90(Dec. 1962). (In Hungarian)

Investigations were carried out on the effect of reflector foil and phosphor dimensions on the resolution of a scintillation beta spectrometer and on the relation between energy and pulse height. According to the measurements, the application of an Al reflector foil does not involve considerable advantages, whereas vacuum evaporation of Al on the phosphor surface will reduce the pulse height by more than half the initial value. The optimum phosphor thickness is a function of energy to be measured. With phosphor layers thicker than the optimum value, the resolving power and the pulse decrease. Further increase of the scintillator diameter may involve considerable drawbacks. The application of a photo-conductor was found definitely disadvantageous. (auth)

20367 PERSONAL EXPOSURE INDICATOR. Martonne Békés and Zsigmond Makra. Magy. Tud. Akad. Kozp. Fiz. Kut. Int. Kozlemen., 9: 251-62(1961).

A personal indicator is described, which, together with newly developed types of film holders, permits the determination of the β and γ dosage as well as that of thermal neutrons, between 20 and 200 rads. Beta and γ rays are recorded in one holder fitted with Pb and Cu filters, whereas thermal neutrons are measured in another holder with Cd and Sn filters. The energy of x and γ radiation is evaluated according to the difference in the blackening of film, with the aid of two Cu filters of different thickness, the extent of error being 25%. The dosage of β rays is indicated by the extent of blackening of the film, which lies under the hollow part of the holder. The films were sensitive for up to 1 month and were developed along with the control film, which was calibrated with the aid of standard radiation sources. (OTS)

20368 RESPONSE OF A LARGE NaI(Tl) CRYSTAL TO HIGH ENERGY ELECTRONS. Lee G. Pondrom and Alan Strelzoff (Columbia Univ., New York). Rev. Sci. Instr., 34: 362-5(Apr. 1963).

The resolution function of a 9-in.-dia by 10-in.-long cylindrical NaI(Tl) crystal for incident electrons of 55-, 72-, and 83-Mev energy was measured. A wedge magnet defined the electron energy. Spark chambers were used on either side of the magnet to insure against spurious scattering of electrons and to estimate the magnet system momentum spread. The most probable pulse height from the crystal varied linearly with electron energy. The pulse-height distribution had a full width at half-maximum of 13.4 + 0.3 or −0.7%. (auth)

20369 MICROPLASMAS IN SILICON p-n JUNCTIONS AS DETECTORS FOR GAMMA RADIATION. Ingolf Ruge and Guenter Keil (Technische Hochschule, Munich). Rev. Sci. Instr., 34: 390-2(Apr. 1963).

A counting device of very small dimensions is described which may perferably be used as counter for γ radiation. When operating a silicon diode (alloyed type) in its pre-breakdown region, where the breakdown is unstable and giving voltage pulses, the rate of these pulses is a linear function of the incident radiation. In that way the device shows a behavior like a Geiger-Müller tube with large breakdown pulses and small "deadtime" (several microseconds). Measurements were taken with a 350-C Co^{60} source in the range of 10 to 10^4 r/hr. As an extrapolation indicates, the device may be used for dose rate measurements up to 10^7 r/hr. Temperature and time stability of the effect are discussed. (auth)

20370 NEW DESIGN FOR A GAS-FLOW PROPORTIONAL COUNTER. F. Behn Riggs, Jr. (Smithsonian Astrophysical Observatory, Cambridge, Mass.). Rev. Sci. Instr., 34: 392-5(Apr. 1963).

A compact design for a gas-flow proportional counter is described. Externally adjustable end plates for correcting the electric field allow pulse-height distribution curves comparable with those from long counters, although the counting volume is $1\frac{1}{4}$ in. in diameter and $1\frac{1}{16}$ in. long. A transistorized preamplifier inside the counter case provides clear pulses with low background in a low impedance line. The gas-flow proportional counter described has three significant features: (1) low noise, approximately 1% of the FeK_{α} pulse height; (2) low impedance output from the first preamplifier; (3) energy spread less than 20%, in spite of short length and large diameter. (auth)

20371 SOLID STATE DOSIMETRY. John F. Fowler (Saint Bartholomew's Medical Coll., London). Phys. Med. Biol., 8: 1-32(Apr. 1963).

Solid-state devices are useful for their high sensitivity in a small volume, as in semiconducting dose-rate measuring devices; for storing a dose reading for a convenient period; or for showing the position of radiation fields. Scintillators, photographic films, and neutron activation foils are not discussed. Thermoluminescent materials are being developed that are useful in the dose range from a few millirads to 10^5 rads. When made generally available, they will be suitable for personnel protection, for clinical measurements, and for radiobiological measurements. Radiophotoluminescent glasses are available now, and are useful in the range from a few tens of rads up to 10^4 rads. They were used for in vivo tissue dosimetry. Color changes in glasses, plastics, and dyes were used to monitor doses in industrial processing, in research with high-intensity electron beams, and to measure dosage distributions in radiotherapy. Electron spin resonance in alanine, infra-red stimulated luminescence, and the quenching of natural luminescence also provide dose measurement. Dose rate measuring devices include p-n junctions, cadmium sulfide cells, and insulating organic materials. These solid-state systems are reviewed, and the practical applications and shortcomings of the techniques are discussed. It is also of interest to explore the limitations of any of these systems for giving fundamental data, or for providing LET-sensitive micro-dosimeters. (auth)

20372 A p-n JUNCTION PHOTOVOLTAIC DETECTOR FOR USE IN RADIOTHERAPY. D. Whelpton and B. W. Watson (Sheffield Regional Medical Physics Department, Eng.). Phys. Med. Biol., 8: 33-42(Apr. 1963).

A radiation detector in the form of a shielded p-n junction is described. The junction with the appropriate shielding is quality independent over the range 0.8 to 14 mm Cu H.V.T. to better than 10%, and, with the instrumentation described, the output voltage is proportional to the incident dose rate (to within 5%) over the range 0.3 to 750 r/min. Also described are the temperature and polar responses, as well as measurement of radiation damage from Co^{60} γ rays. A comparison is made between the p-n junction detector and a cadmium sulfide probe. The development of probes of smaller physical dimensions and to measure lower dose rates is discussed. (auth)

20373 THE DETERMINATION OF SATURATION CURRENTS IN FREE-AIR IONIZATION CHAMBERS BY EXTRAPOLATION METHODS. Patricia B. Scott and J. R. Greening (Edinburgh Univ.). Phys. Med. Biol., 8: 51-7 (Apr. 1963).

The usual method of determining saturation currents in free-air chambers is to plot the reciprocal of the current, j, against the reciprocal of the collecting electric field, E, and extrapolate linearly to $1/E = 0$. It is shown that this method is valid only if the recombination taking place is initial recombination within ion clusters. Experimental and theoretical evidence is produced to show that in such chambers, at dose rates of 1 r/min or more, it is general (volume) rather than initial recombination that is taking place. Theory shows that under these circumstances one should plot $1/j$ against $1/E^2$, or more accurately against j/E^2, and extrapolate to $1/E^2$ or $j/E^2 = 0$. (auth)

20374 TIME INTERVAL AND RESOLVING TIME MEASUREMENTS USING SCALING CIRCUITS. H. Lindeman and E. Mornel (Israel Inst. of Tech., Haifa). Physica, 29: 105-10(Feb. 1963). (In English)

Using a time-interval counting circuit, distribution functions of time intervals were measured for pulses obtained from a G-M counter in combination with a scaling circuit. For low counting rates the experimental values were in good agreement with those calculated from the theoretical expressions, neglecting the effect of the finite resolving time of the counter. For high counting rates this effect is not only considerable, but its influence on the interval distribution function grows with increasing values of the scaling factor. It is shown that this fact enables the measurement of resolving times with great precision. (auth)

20375 X-RAY FILM AS A MEASURE OF X-RAY AND γ-RADIATION DOSES. Jan Jagielak. Zeszyty Nauk. Politech. Warsaw., Elek., No. 27, 101-6(1962).

Studies were made to obtain a convenient monitoring method for personnel working with x- and γ-ray sources. The x-ray film was Rentgen Super R and the radiation sources were an x-ray tube working at voltages from 43 to 160 kev_{eff} (corresponding to wavelengths of 0.277 to 0.077 Å) and γ-active nuclides Ir^{192} (430 kev), Cs^{137} (661 kev), Ra (860 kev), and Co^{60} (1250 kev). To eliminate the effect of the wavelength of x and γ rays on the film blackening, metal absorbers were used. Cadmium, Zn, and Pb foil were tried. The best results were obtained with an absorber consisting of 0.75 mm Cd + 0.2 mm Pb. With this absorber, radiation doses could be measured in the range 0.1 to 8 r for photon energies from 70 to 300 kev. (OTS)

20376 PARAMAGNETIC COUNTER FOR ELEMENTARY PARTICLES. U. Kh. Kopvillem and B. M. Khabibullin (Kazan Inst. of Physics and Tech.). Zh. Eksperim. i Teor. Fiz., 44: 749-52(Feb. 1963). (In Russian)

The efficiency and sensitivity of a paramagnetic neutron counter were estimated, and possibilities of using paramagnetic crystals in detecting and investigating the properties of elementary particles were analyzed. The paramagnetic neutron counter, operating at helium temperature, uses a CeF_3 crystal in which the $E_2 - E_1$ for $Ce^{3+} \sim 150$ cm^{-1}, $E_3 - E_2 \sim 2100$ cm^{-1}, $\sigma_{12} \sim 1.6$ b, $\sigma_n(Ce^{140}) = 0.62$ b, and $\sigma_n(F^{19}) < 10$ mb. Calculations suggested that quantum counters with a paramagnetic spin-system at super-low temperature (0.1 to 0.001°K) should exhibit a higher sensitivity than any other counter and should be capable of detecting uncharged particles (neutrino) by magnetic scattering in the spin system. (R.V.J.)

20377 DIELECTRODE SPARK DETECTOR WITH LARGE DISCHARGE INTERVALS IN MAGNETIC FIELD. A. I. Alikhanyan, T. L. Asatiani, and E. M. Matevosyan (Erivan Inst. of Physics, USSR). Zh. Eksperim. i Teor. Fiz., 44: 773-5(Feb. 1963). (In Russian)

Charged particle trajectories were measured with a

spark detector, with large discharge intervals, in a 5×10^3 gauss magnetic field. The $20 \times 40 \times 21$ cm^3 chamber, pumped to 3×10^{-2} mm Hg, and filled with neon to 1.5 atm was efficient for particles of up to tens of Bev/c. (R.V.J.)

20378 ZÄHLROHRE UND SZINTILLATIONSZÄHLER. MESSMETHODEN FÜR DIE STRAHLUNG DER KÜNSTLICHEN UND NATÜRLICH-RADIOAKTIVEN SUBSTANZEN. (Counters and Scintillation Counting. Measuring Methods for the Radiation of Artificial and Natural Radioactive Substances). Ewald Fuenfer and Hugo Neuert. Karlsruhe, Verlag G. Braun, [1959]. 366p.

A survey of the development of counting methods for particles and quanta is presented. The physical processes in proportional, extinction, Cherenkov, scintillation, and crystal counters are described. Physical and technical aids in construction of counting tubes are discussed including counter statistics and circuits. (M.C.G.)

20379 PROPOSALS FOR SOME MULTIPLE DETECTOR SYSTEMS FOR MEASUREMENT OF PARTICLE TRAJECTORIES. Kjell Budal. Preprint No. 6. 14p.

Paper from Proceedings of the Physics Seminar in Trondheim, 1962.

Ideas for multiple counter chambers, based on gas discharge detectors are presented. These counters have the advantage of simplicity and large output signals. Methods where only one as a limited group of detectors is analysed at the same time are discussed. The discharge pulses are stored or delayed until analysis can take place. (C.E.S.)

20380 IMPROVEMENTS IN OR RELATING TO SCINTILLATION COUNTERS. Gordon William Pearson and Ronald Arthur Jackson (to United Kingdom Atomic Energy Authority). British Patent 922,435. Apr. 3, 1963. Filed Jan. 26, 1961.

A simple device is designed for loading a sample into a scintillation counter without exposing the photomultiplier tube to extraneous light. The device comprises a cylindrical body part with a sample hole, and a housing for the body part and having two ports. The housing and body are movable relative to each other between two operative positions, one for changing samples and the other for counting. (D.L.C.)

20381 IMPROVEMENTS IN OR RELATING TO ELECTRONIC CONTROL CIRCUITRY FOR DELIVERING A CONTROL SIGNAL OUTPUT IN RESPONSE TO IONISING RADIATION. (to Minneapolis-Honeywell Regulator Co.). British Patent 922,717. Apr. 3, 1963. Priority date Apr. 17, 1958, United States.

An electronic control circuit is designed which includes as a radiation sensor a non-self-quenching Geiger-Mueller tube. The circuit also includes two discharge tubes connected to form a monostable multivibrator network, and the Geiger tube is connected between the discharge tubes in such a way that it has an operating voltage in the stable condition of the network and is quenched by the unstable multivibrator condition. The Geiger tube itself triggers the network from its stable to unstable condition when it conducts in response to radiation. (D.L.C.)

20382 DOSIMETERS. (to Landis & Gyr A. G.). British Patent 922,895. Apr. 3, 1963. Priority date June 9, 1960, Switzerland.

A dosimeter is designed which may be combined with an identification tag and which can be read immediately at any time. The dosimeter includes a housing for an ionization chamber enclosing a coiled capacitor, a discharge electrode, and a movable charging contact. (D.L.C.)

20383 APPARATUS FOR MEASURING NUCLEAR RADIATION. Walter P. Kern, Hugh F. Stoddart, and James B. Williams (to Baird-Atomic, Inc.). U. S. Patent 3,085,155. Apr. 9, 1963. Filed Apr. 17, 1959.

An apparatus is designed for detecting the scintillation of a liquid in which a radioactive sample is dispersed. The apparatus comprises a housing with a compartment, sample magazines for mounting in the compartment, and means for preventing undesired light from reaching the photomultiplier tube in the housing. (D.L.C.)

20384 APPARATUS FOR MEASURING THE AMOUNT OF URANIUM CONTAMINATION ON THE OUTER SURFACES OF FUEL ELEMENTS. John William George Gregory and Richard Bruce Owen (to United Kingdom Atomic Energy Authority). U. S. Patent 3,085,156. Apr. 9, 1963. Priority date Mar. 28, 1958, Great Britain.

An alpha-counting apparatus is designed for the relatively rapid detection of contamination of the exterior of fuel elements. The apparatus comprises an evacuable chamber with means for inserting and withdrawing a fuel element, an anode collection system, and a guard electrode between the anode and the chamber. The apparatus is constructed out of a material with a low rate of alpha emission such as steel, and a gas ionizable by alphas, e.g., argon, is introduced into the chamber. (D.L.C.)

20385 APPARATUS FOR DETERMINING RADIOACTIVE MATERIAL RATIOS. Richard M. Powers (to Sylvania Electric Products, Inc.). U. S. Patent 3,086,116. Apr. 16, 1963. Filed Mar. 24, 1959.

An apparatus and a method are described for determining the percentages of different radioactive materials in a mixture. The method is based on the measurement of alpha-particle emission rates at different distances from the mixture. In this method, the mixture is placed in an enclosed chamber, the atmospheric pressure in the chamber is reduced to, say, 0.10 atm., and the alpha count is measured at different places with a scintillation detector. The use of the method is illustrated for a $U^{235}-U^{238}$ mixture. (D.L.C.)

20386 SEMICONDUCTIVE DOSIMETERS. Claude A. Klein and Wolf Deter Straub (to Raytheon Co.). U. S. Patent 3,086,117. Apr. 16, 1963. Filed July 20, 1959.

A semiconductive dosimeter is designed for obtaining an integrated dose of both fast and slow neutrons. The dosimeter comprises an envelope, a body of semiconductor material, and a body of material capable of converting thermal neutrons into fast particles adjacent to the semiconductor body. The semiconductor may be germanium, while the second material may be lithium. Two embodiments of the dosimeter are described. (D.L.C.)

ISOTOPE SEPARATION

20387 THE TRANSFORMATION PRINCIPLE OF THE SEPARATION TUBE CASCADE. G. Dickel and D. Schildknecht (Universität, Munich). Z. Naturforsch., 18a: 105-11(Feb. 1963). (In German)

It is shown that for separation of a specific gas in a separation tube, a two-parameter group of Cohen's ideal separation cascades exists if equal (electric) power absorption of all concurrent cascades is required. The whole of all these cascades is contained in the dimension equation with which a correlation between length, slit width, and cascade width can be constructed and by means of which the total variety of all cascades present for selection can be looked over. Each one of these cascades can be characterized by three quantities which are invariant. Should a different gas be passed through for separation and at the same time the optimum efficiency remain the same, then these 3 quantities must remain invariant. That is possible for suitable choice of operating conditions. (tr-auth)

20388 ENRICHMENT OF LITHIUM ISOTOPES BY COUNTERCURRENT ELECTROLYSIS IN AQUEOUS SOLUTIONS. W. Thiemann and K. Wagener (Hahn-Meitner-Institut für Kernforschung, Berlin). Z. Naturforsch., 18a: 228-35(Feb. 1963). (In German)

An electrolytic separation process is described that allows the separation of ions in aqueous solution in a continuous manner. It is of high separative power and therefore especially designed for the separation of ions with very small difference in the ion mobility. In comparison with electrophoresis it has the advantage of much greater amounts processable at one time. The process was applied to enrich the natural lithium isotopes which have an unusually small difference in their ion mobilities of only 0.08%. Using an apparatus of more than 3000 theoretical plates the separation factor was 12.8. The content of Li^6 in the samples was determined by activation analysis. (auth)

20389 SEPARATION NOZZLE DISSOCIATION OF URANIUM ISOTOPES BY USE OF LIGHT ADMIXED GASES. E. W. Becker, K. Bier, W. Bier, and R. Schuette (Technische Hochschule, Karlsruhe, Ger.). Z. Naturforsch., 18a: 246-50(Feb. 1963). (In German)

For the separation of uranium isotopes, in a working slit-formed separation nozzle arrangement with free expansion by an addition of 400 mol % He to UF_6 the specific adsorption volume could be lowered $1/4$ and the specific slit length $1/2$ compared with optimum values achieved with pure UF_6. At the same time the specific compression work increased to 4 times the earlier optimum value. On the other hand for a separation nozzle system in which the jet was mechanically turned 180°, with a mixture of 5 mol % UF_6 and 95 mol % He, the same decrease of specific adsorption volume and a decrease of the specific slit length to $1/30$ were attained while the specific compression work at the same time climbed only about 20%. By means of the strong decrease achieved by the bent system the controlling specific expenditure for investment cost improved the economic situation of the separation nozzle process considerably. Nevertheless the separation nozzle process in the present condition of development may show advantages over the diffusion process only at high enrichments of U^{235}, at which the lower number of stages, the omission of fine-pored membranes, and the expected smaller adjustment time are important. (tr-auth)

20390 A PROCESS FOR OBTAINING ISOTOPES OF AN ELEMENT OR A COMPOUND CONTAINING SUCH AN ISOTOPE. Pierre Maldague. British Patent 923,852. Apr. 18, 1963. Priority date Aug. 4, 1958, Luxemburg.

A process for separating isotopes of an element is outlined which is efficient and does not require large amounts of energy. The process comprises subjecting the mixture of a compound of the isotopes to monochromatic radiation at a wavelength corresponding to the molecular resonance peak of the compound of the desired isotope, and separating the dissociated isotope. An example of the process is described in which D_2 is produced by dissociation of DX (X = halogen) in a HX mixture. (D.L.C.)

20391 SEPARATION OF LITHIUM ISOTOPES. Kurt Peters. U. S. Patent 3,085,852. Apr. 16, 1963. Filed Apr. 23, 1957.

The method and apparatus used are described for the chemical separation of Li^6 and Li^7 by fractional precipitation from a solution in which the Li isotopes are present as specific complex ions. The complex ions used, in addition to Li, are Al, Cr, Mo, W, U, V, Nb, and Ta, and at least one radical of at least one polybasic organic acid-oxalic, citric, or tartaric. The best results are obtained with Al salts. The separation of the complex ions is effected by carefully controlled fractional precipitation from a substantially homogeneous environment. (P.C.H.)

MATHEMATICS AND COMPUTERS

20392 (JUL-101-PP) POSITIVE HALBGRUPPEN AUF EINEM n-DIMENSIONALEN TORUS. (Positive Semi-Groups on an n-Dimensional Torus). Wilhelm von Waldenfels (Kernforschungsanlage. Institut fur Plasmaphysik, Jülich, Germany). Feb. 1963. 20p.

A positive semi-group is a family $\{U(t), t \geq 0\}$ of positive linear operators over a space-continuous function of a basic set (here the n-dimensional torus). The positive semi-groups are used in the theory of Markow's stochastic methods. In previous work on Markow's semi-groups of real axis, the conditions of interchangeability, which signify the space homogeneity of the semi-groups, could be substituted for weak plain assumptions. This work was extended to cover multi-dimensional basic regions and only positive semi-groups. Not the entire R^n, but only a periodicity cube were considered. (M.C.G.)

20393 (LA-2837) LASL LENS DESIGN PROGRAM FOR THE IBM 7090. C. A. Lehman (Los Alamos Scientific Lab., N. Mex.). Feb. 1963. Contract W-7405-eng-36. 113p.

A program for the design of optical lens systems by the method of least squares was written for use on the IBM 7090. The program was found to work very well in improving existing lens designs. A theoretical development of the equations used by the program is given as well as information for those desiring to use the program. Sample problems are included. (auth)

20394 (ORNL-3423) MATHEMATICS DIVISION ANNUAL PROGRESS REPORT FOR PERIOD ENDING DECEMBER 31, 1962. (Oak Ridge National Lab., Tenn.). Apr. 17, 1963. Contract W-7405-eng-26. 65p.

Research on numerical analysis, biological and medical statistics, and programming is reported. Programming and analysis work involved chemistry, health physics, analytical chemistry and chemical technology, neutron physics, physics, reactors, reactor chemistry, metallurgy, and computer operation and programming. Agricultural research and the training courses offered are also reported. A list of lectures, papers, and publications for the report period is included. (D.C.W.)

20395 (SCR-501) TABLES OF ROOTS OF THE FIRST TEN THOUSAND INTEGERS. C. B. Bailey and G. E. Reis (Sandia Corp., Albuquerque, N. Mex.). Jan. 1963. Contract [AT(29-1)-789]. 237p.

As an aid for people who use desk calculators frequently, values of $N^{\frac{1}{2}}$, $(10N)^{\frac{1}{2}}$, $N^{\frac{1}{3}}$, $(10N)^{\frac{1}{3}}$, $(100N)^{\frac{1}{3}}$, $N^{\frac{1}{4}}$, $(10N)^{\frac{1}{4}}$, $(100N)^{\frac{1}{4}}$, and $1000N)^{\frac{1}{4}}$ were computed to nine decimal places for the first 10,000 integer values of N. The first ten roots of the first 1000 integers and of several functions of e, π, and γ (Euler's constant) were also computed. The computational procedure is discussed. (D.C.W.)

20396 REMARKS ON A THEOREM IN CLASSICAL ENSEMBLE THEORY. P. Bocchieri and A. Loinger (Università, Pavia, Italy and Istituto Nazionale di Fisica Nucleare, Milan). Phys. Letters, 4: 188-90(Apr. 1, 1963). (In English)

Further considerations in the classical ensemble theory are presented to illustrate the role of the time evolution of the physical system and to explain the mathematics and physics underlying the functional averaging method employed. An attempt is made to justify the canonical distribution law of classical statistical mechanics. (C.E.S.)

20397 REDUCTION FORMULA FOR THE FIVE-POINT FUNCTION. Francis R. Halpern (Univ. of California, San Diego). Phys. Rev. Letters, 10: 310-12(Apr. 1, 1963).

In analyzing the singularities of the pentagon diagram in four-dimensional space-time, it is shown that the integral for the pentagon can be written as the sum of several four-point functions. (C.E.S.)

20398 HAUSDORFF SUMMABILITY METHODS, ADDENDUM. B. E. Rhoades (Argonne National Lab., Ill. and Lafayette Coll., Easton, Penna.). Trans. Am. Math. Soc., 106: 254-8(Feb. 1963). (TID-16214)

Three theorems are proven: (1) $H \sim \alpha_2(t,r)n.t.s.\ H \sim \alpha_3(t, r)$. (2) For $b-1 > -k/\log r$, $H \sim \alpha_1(t,k,b)n.t.s.\ H \sim \alpha_3(t,r)$. (3) For $k > 4$, $H \sim \alpha_1(t,k+1,c)n.t.s.\ H \sim \alpha_1(t,k,c)$. The technique used in proving these theorems is to show that the corresponding mass function is decreasing at least one point in the unit interval. (D.L.C.)

METALS, CERAMICS, AND OTHER MATERIALS

General and Miscellaneous

Refer also to abstracts 19726, 20312, 21231, 21235, 21268, 21269, and 21341.

20399 (AD-282022) SECOND QUARTERLY PROGRESS REPORT OF THE CY 1962 AIR FORCE-MARQUARDT CONTRIBUTING ENGINEERING PROGRAM. VOLUME II. Report No. 25,054. (Marquardt Corp., Van Nuys, Calif.). July 31, 1962. Contract AF33(600)-40809. 40p.

Welding and brazing techniques are being developed for W and 90% Ta–10% W alloy in thin sheets of 0.040-in. thickness. Nondestructive test techniques indicated that laminations were present in the tungsten sheet. The selected braze alloys showed that they possess the desired wettability for brazing the Ta–W alloys. Oxidation protection of W and Ta–W alloy by coatings is also being studied. Fabrication techniques are being developed for anisotropic forms of refractory materials. Efforts were made to optimize deposition parameters for SiC. (M.C.G.)

20400 (AGN-8062) ENGINEERING INVESTIGATIONS OF CENTRIFUGAL CREEP TESTING MACHINE. Final Report. (Aerojet-General Nucleonics, San Ramon, Calif.). Feb. 1963. Contract AT(04-3)-368. 187p.

Multi-specimen creep tests can be conducted by centrifugal cantilever bend testing. The deflection-rpm data are convertible into creep-tension values with specimens of tapered design; this is demonstrated with centrifugal creep tests on Al, Fe, and Zircaloy-2. A theory is developed which indicates that creep approaches purely plastic behavior at very low strain rates, and purely elastic behavior at very high strain rates. The applicability of centrifugal creep testing to the study of alloy systems is demonstrated with creep tests on Fe–Al alloys. A centrifugal method for measuring the Young's modulus at elevated temperatures is described. The activation energies for the creep of Fe, Fe–Al alloys, and Zircaloy-2 were obtained by centrifugal bend testing. It is found that the activation energy for Zircaloy-2 increases with increasing stress. Centrifugal creep data on Zircaloy-2 are correlated with conventional creep data obtained at Chalk River. Miniaturization tests on Zircaloy-2 were carried out at constant stress by programming the rotational speed. For good data reproducibility, the minimum specimen width should not be less than 0.48 in., and the minimum test head size not less than 3 in. Strains in excess of 1% can be obtained on 18 test specimens simultaneously in a 4 in. diameter test hole (exclusive of space occupied by furnace and casing). A wedge-type test head was developed, which eliminates the need for individual set-screws for attaching test specimens. A preliminary centrifugal bend test program was conducted at 1850°F on alumina, ATJ and pyrolytic graphites, and two silicates. Measurable creep with limited scatter was obtained with simple, weighted specimens. The stress-rupture values were measured. However, a more sophisticated specimen design is necessary for avoiding the maximum stress and strain localization, with its implied data scatter. The testing should be conducted at considerably higher temperatures in order to obtain significant amounts of creep. (auth)

20401 (BMI-1625) OXIDATION RESISTANCE OF OXIDE-COATED UO_2 MICROSPHERES. George W. Cunningham, William H. Pfeifer, Donald C. Carmichael, and Edwin S. Hodge (Battelle Memorial Inst., Columbus, Ohio). Apr. 2, 1963. Contract W-7405-eng-92. 30p.

The mechanism and kinetics of oxidation of spherical UO_2 particles coated with Al_2O_3, BeO, and MgO, were studied by thermogravimetric techniques. Metallographic and x-ray-diffraction data were obtained to support the conclusions. At temperatures below 1500°C, oxidation of Al_2O_3-coated particles occurred by diffusion of oxygen through the coatings, partial oxidation to U_3O_8, and subsequent cracking and complete oxidation. Oxidation resistance of Al_2O_3 particles coated at 1300 and 1400°C was superior to that of particles coated at 1000°C. Extrapolation of the measured data indicated that the particles coated at 1300 and 1400°C should have satisfactory oxidation resistance for several thousand hours at temperatures of 1100°C and lower. Beryllia-coated particles were also found to have good oxidation resistance at 1100°C, but BeO coated particles were more sensitive to thermal stresses than Al_2O_3-coated particles. Magnesia-coated particles failed due to thermal stresses at 800 to 900°C. (auth)

20402 (GEAP-3880(Pt.I)) COMPARATIVE STUDY OF PuC–UC AND PuO_2–UO_2 AS FAST REACTOR FUEL. PART I. TECHNICAL CONSIDERATIONS. K. M. Horst and B. A. Hutchins (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 19, 1962. Contract AT(04-3)-189. 70p.

The design characteristics and potential fuel cycle economics of Pu–UC and Pu–UO_2 fuels in large fast-spectrum liquid-metal-cooled reactors are compared. Results indicate that in order to use carbide fuel for improvement over the oxide fuel economics, a number of difficult problems must be overcome; however, successful development of high-performance fuel would lead to potential reductions in the fuel cycle cost of about 0.3 mills/kwh. (J.R.D.)

20403 (NAA-SR-Memo-6836) FABRICATION AND PROPERTIES OF THE METAL HYDRIDES. J. B. Vetrano (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Nov. 1, 1961. Contract [AT (11-1)-Gen-8]. 12p.

Techniques developed for forming rods, plates, and special configurations of zirconium and other metal hydrides are presented. The products are dense and sound, with maximum thermal and electric conductivities. Applications of the hydrides are also discussed. (P.C.H.)

20404 (NP-12682) APPARATUS FOR MEASUREMENT OF THE INTERNAL FRICTION OF METALS AT KILOCYCLE FREQUENCIES. Report No. 64. E. W. Dickson and H. Strauch (Tube Investments Research Labs., Hinxton Hall, Cambridge, England). Oct. 13, 1958. 28p.

An apparatus was constructed to measure the internal friction of metal specimens, in this case Be, at frequencies of ~30 kc/s. Though similar to that used elsewhere, this apparatus has the unique feature of a regenerative circuit which gives complete control of the amplitude of oscillation of the metal specimen. It also allows a precise determination of the resonance frequency and hence Young's modulus for the specimen. A method of calculating the vibration amplitude is given together with brief details of the electrostatic detection circuit. The apparatus is being used in a study of the interaction between impurity atoms and dislocations, which forms part of the

research program on the plastic deformation properties of Be. (auth)

20405 (NP-12710) RESEARCH ON PHYSICAL AND CHEMICAL PRINCIPLES AFFECTING HIGH TEMPERATURE MATERIALS FOR ROCKET NOZZLES. Quarterly Progress Report, January 1, 1963–March 31, 1963. Robert Lowrie (Union Carbide Corp. Research Inst., Tarrytown, N. Y. and Union Carbide Corp. Parma Research Lab., Ohio). Mar. 31, 1963. Contract DA-30-069-ORD-2787. 89p.

Data are reported on the oxidation of TiC, HfC, HfB_2, and TaB_2 by CO_2 at 2250°C. Those for HfC and HfB_2 generally confirmed the conclusion that an adherent oxide layer progressively retards the rate of reaction of carbides and diborides with CO_2. Anomalies were encountered in a high initial rate of reaction for HfB_2 and in a large difference in reaction rate between hot-pressed TiC and arc-melted TiC. Corrosion tests on ZrC–NbC solid solutions in CO_2 indicated the development of protective oxide layers. Weight-loss experiments indicate that there is little or no boron in the adhering portion of the products of oxidation of ZrB_2 or HfB_2 by CO_2. Since HCl is known to react with ZrO_2, it might be expected to reduce or prevent the formation of a protective ZrO_2 coating on ZrC when added to the CO_2 in a high-temperature corrosion test. This effect was found, and for a wide range of CO_2/HCl ratios the amount of corrosion was greater than the sum of reactions with CO_2 and HCl individually. Data are also presented on the corrosion of TiC, ZrC, NbB_2, and TaB_2 by HCl at 2250°C. The corrosion of ZTA graphite by oxygen was studied, and this rate of corrosion was about three times that of ZTA in CO_2 at 2250°C. If both rates were limited by the rates of gas diffusion this factor would be about two. This small discrepancy, the greater temperature dependence of the reaction with CO_2, and the much greater development of porosity during oxidation by CO_2 suggest that over the temperature range studied in the experimental arrangement gas diffusion is not the only significant rate-determining step for the reaction of CO_2 with ZTA graphite, while it is the rate-determining step for the O_2 reaction. A small, high-pressure burner was obtained in which a tubular sample can be subjected to more severe conditions of temperature, pressure, and velocity than can be attained in our other equipment. Calculations of the fuel, oxygen, and diluent flow rates to attain specific combustion temperatures and exhaust compositions are being carried out on the UCC IBM 7090 Computer. The products obtained when a molecular beam of oxygen impinges on a hot tungsten filament were determined for filament temperatures from 800 to 2200°C. With increasing temperature the predominant tungsten-bearing ions detected mass spectrometrically were in turn $(WO_3)_3^+$, $(WO_3)_2^+$, WO_3^+, WO_2^+, and W^+. The thermal expansion of TaC was measured by an x-ray method to 2044°C, and a value was obtained for the expansion of NbC at 2031°C to complete the measurements on that compound. The first measurements of the thermal expansions of solid solutions were made on 25 TiC–75 ZrC up to 1771°C. A discussion is given, in terms of band models, of the galvanomagnetic measurements which were made on various refractory carbides, nitrides, and solid solutions between them. A method for calculating upper and lower bounds for the elastic moduli of a randomly oriented polycrystalline body from the elastic constants of a single crystal of the material was applied to single-crystal data previously obtained for TiC and ZrC. The resulting upper and lower limits are very close, and average values are reported for the shear moduli, Young's moduli, and Poisson's ratios of these compounds. Tungsten was successfully brazed to tungsten and this method will be used to prepare specimens for measurements of the elastic constants of tungsten single crystals to 1800°C. Creep tests on two large-grained specimens of ZrC resulted in brittle fractures during or shortly after the applications of load increments at 1635° and 1815°C. This appeared to indicate that ZrC is brittle to considerably higher temperatures than is TiC, though the possibility of defective samples must also be considered. Two further creep tests on TiC were made. The activation energies obtained from all the creep tests on TiC fell into two groups, near 125 and 170 kcal, with some indication that the activation energy is a function of the creep strain at which the determination was made. Measurements by the rectangular-bar method of thermal conductivity, electrical resistivity, and total emissivity were begun on samples of TiC, and samples of ZrC and HfC are on hand to be measured. Work on the preparation of homogeneous solid solutions between the monocarbides of the Group IV and V transition metals was continued by raising the temperatures of homogenization, usually to 2700°C. General improvement resulted, and most of the materials are now single phase, but only one solid solution (25 TiC–75 ZrC) produced sharp enough x-ray lines for resolution of the $K\alpha_1 - K\alpha_2$ doublet. The equipment for levitation melting, zone refining, zone sintering, and controlled drip melting was received and is being reassembled and tested. (auth)

20406 (TEI-830) X-RAY CRYSTALLOGRAPHIC DATA FOR MINERALS. Richard A. Robie, Philip M. Bethke, Martha S. Toulmin, and Jerry L. Edwards (Geological Survey, Washington, D. C.). Feb. 1963. 39p.

Selected crystallographic data are tabulated for approximately 300 elements and compounds. 183 references are cited. (P.C.H.)

20407 ADVANCED TECHNIQUES IN POWDER METALLURGY. An AEC Monograph. Frances Clark. Monograph Series on Metallurgy in Nuclear Technology. New York, Rowman and Littlefield, Inc., 1963. 185p. $4.45(Paper Binding), $6.95(Library Binding).

Information and data concerning recent developments in powder metallurgy are presented. Discussions are included on relations of specific powder properties to characteristics, use of metal powders without consolidation, and new consolidation methods. Information is included on theory and practice of sintering along with discussions concerning the role of porous metal structures and properties of hard carbides and magnetic metal powders. Information is also included on toxicity and pyrophorocity of metal powders, creep, and testing techniques. (J.R.D.)

20408 METHOD FOR PRODUCING THE REFRACTORY METALS HAFNIUM, TITANIUM, VANADIUM, SILICON, ZIRCONIUM, THORIUM, COLUMBIUM, AND CHROMIUM. Kenneth Frank Griffiths. U. S. Patent 3,085,871. Apr. 16, 1963. Filed Feb. 24, 1958.

A method and the apparatus used for the liquid phase production of Ti, V, Si, Hf, Zr, Th, Nb, and Cr by the reduction of a halide of the desired metal with a suitable reducing agent in an atmosphere rich in either metal product halide gas, reducing agent gas, or some suitable inert gas are described. The reducing agents are Li, Na, K, Rb, Cs, Mg, and Ca, with Na being preferred. Conditions for the process are listed. (P.C.H.)

20409 METHOD FOR PRODUCING THE REFRACTORY METALS HAFNIUM, TITANIUM, VANADIUM, SILICON, ZIRCONIUM, THORIUM, COLUMBIUM, AND CHRO-

MIUM. Kenneth Frank Griffiths. U. S. Patent 3,085,872. Apr. 16, 1963. Filed July 1, 1958.

A method and the apparatus used for the liquid phase production of Ti, Zr, V, Hf, Si, Th, Cr, and Nb by the reduction of a halide of the desired metal with a sufficient amount of reducing agent in a zone surrounded by a two-component agent halide supported by a metal product lining are described. Suitable reducing agents are Li, Na, K, Rb, Cs, Mg, and Ca. Na is preferred for the production of Ti, V, Zr, Si, Th, and Cr, and Ca and Mg for the production of Nb because their fluorides have much lower vapor pressures than any of the halides of the other reducing agents at the melting point of Nb. (P.C.H.)

20410 METHOD FOR COLLECTING AND SEPARATING THE REFRACTORY METAL COMPONENT FROM THE REACTION PRODUCTS IN THE PRODUCTION OF THE REFRACTORY METALS TITANIUM, ZIRCONIUM, VANADIUM, HAFNIUM, SILICON, THORIUM, CHROMIUM, OR COLUMBIUM. Kenneth Frank Griffiths. U. S. Patent 3,085,873. Apr. 16, 1963. Filed Nov. 7, 1958.

A method and the equipment used for collecting and separating reaction products in the production of the refractory metals Ti, Zr, V, Hf, Si, Th, Cr, and Nb are described. The process consists of collecting and gravitationally separating the metal product and reducing agent in the process in which the temperature of the collecting and separating reaction products is controlled by means of the deposition of a thin refractory metal sponge lining on the walls of a collection chamber, which acts as a thermal barrier. The general conditions are listed for the continuous reaction of metal product halide with a stream of reducing agent in a reaction chamber. The reaction apparatus is described in detail. (P.C.H.)

Corrosion

Refer also to abstracts 21226, 21227, 21228, 21229, 21342, and 21347.

20411 (AD-282638) IMPROVED OXIDATION RESISTANCE OF MOLYBDENUM BY ALLOYING WITH RARE EARTH AND OTHER SELECTED METALS. Interim Report No. 4, May 1, 1962–June 30, 1962. (Colorado School of Mines Research Foundation, Inc., Golden). July 27, 1962. Contract NOw-62-0305-d. 8p.

A new method of forming a protective oxide scale on Mo–Hf and Mo–Y alloys was introduced by using a combination of selective oxidation and sacrificial oxidation. Oxidation experiments were carried out at 725°C on binary Mo alloys containing 2.6 at.% Y and 5.6 at.% Hf in which the Y and the Hf had been selectively oxidized by a process of internal oxidation. The experiments were successful in producing a continuous internal scale from which the outer layer of Mo was then removed by volatilization as MoO_3. Although a continuous scale was produced with the 5.6 at.% Hf alloy it was not completely adherent. It peeled in some places and was quite adherent in others. With 2.6 at.% Y the specimen became coated with a liquid oxide mixture at 725°C, indicating the formation of a low melting point eutectic. A technique for selective oxidation of Mo–Hf alloys in a He atmosphere was developed. The introduction of O from the furnace refractories and other similar sources was eliminated. (auth)

20412 (HW-76952) GAS–METAL REACTIONS WITH IRON- AND NICKEL-BASE HEAT RESISTANT ALLOYS. An Interpretive Literature Survey. D. A. Jones (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1963. Contract AT(45-1)-1350. 23p.

The addition of small amounts of Cr to Ni accelerated oxidation by increasing the density of defects and enhancing diffusion in the oxide scale. However, small amounts of Cr in Fe resulted in formation of dense, defect-free spinel phases in the oxide-scale. Small additions of Al and Cr increased internal oxidation of Fe- and Ni-base alloys. Sufficient quantities of Cr and Al retarded oxidation of Fe- and Ni-base alloys by oxidizing preferentially and forming an adherent, protective, oxide film. The Fe–Cr–Al alloys appear to have sufficient corrosion resistance in most atmospheres at temperatures to 1000°C (1850°F). The Ni-base superalloys retain a reasonable portion of their room-temperature mechanical strength and resist the effects of oxidizing atmospheres at temperatures of 900 to 1200°C. (P.C.H.)

20413 (NAA-SR-Memo-3518) CORROSION TESTS UTILIZING OMRE COOLANTS. D. M. Jones (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Jan. 19, 1959. Contract [AT(11-1)-Gen-8]. 3p.

The corrosive effects of OMRE coolant samples on type 1020 carbon steel were studied. Testing was conducted to determine comparatively any variance in corrosive characteristics due to differing coolant properties in the samples submitted. All specimens tested, with one exception, retained a uniform medium gray surface coloration after exposure. Visual inspection of the specimens produced no evidence of surface deterioration during the exposure period. Weight changes experienced by the carbon steel specimens were small. Also, a bend test showed no indication of embrittlement due to exposure. The results indicate no difference in the corrosivity of the OMRE coolant samples. (P.C.H.)

20414 (ORNL-TM-528) DESIGN AND OPERATION OF FORCED-CIRCULATION CORROSION TESTING LOOPS WITH MOLTEN SALT. J. L. Crowley, W. B. McDonald, and D. L. Clark (Oak Ridge National Lab., Tenn.). May 1, 1963. Contract W-7405-eng-26. 24p.

Standardized test facilities were developed and operated for investigating the compatibility of structural materials and flowing molten fluoride salts. The standard loop accommodates various combinations of materials, fluids, flow rates, and temperature differentials and permits fabrication of components in sufficient quantity for cost reduction. The test loop consists of a pump, two heated sections, a cooled section, a drain tank, and a frozen-plug-type valve. Automatic controls and equipment were developed to prevent solidification of the salt mixtures (mp, 800 to 1100°F) in the event of a loss of power. Most test loops were fabricated of 0.5-in.-OD, 0.045-in.-wall tubing, and operate with a temperature differential of up to 200°F, a maximum wall temperature in the range 1200 to 1500°F, and a salt flow rate of up to 3 gpm. Twenty-five test loops were operated for an accumulated operating time of 290,000 hr. Individual loops were operated continuously for more than one year. (auth)

20415 (TID-16895) AQUEOUS CORROSION OF ZIRCONIUM SINGLE CRYSTALS. A. E. Bibb and J. R. Fascia (Knolls Atomic Power Lab., Schenectady, N. Y.). [Oct. 10, 1962]. Contract [W-31-109-eng-52]. 20p.

Single crystal wafers of Zr were exposed to 680°F neutral water. The single crystals were of known orientation, and weight gain data were obtained as a function of crystal orientation. The data show that all the crystal faces studied

obeyed a cubic rate law out to the time of transition whereupon the crystals corroded at an approximately linear rate. The time to transition varied from 114 days for $(10\bar{1}4)$ crystals to about 325 days for the $(21\bar{3}0)$ faces. The epitaxial relationship between metal and monoclinic oxide was found to be $(0001) \parallel (1\bar{1}1)$ and $[11\bar{2}0] \parallel [10\bar{1}]$. A black tight adherent oxide layer was formed on the crystals in the pre-transition range. The black oxide was found to be monocrystalline. The white corrosion product produced after transition was found to be polycrystalline but highly oriented. X-ray line broadening studies showed that the black oxide was a highly strained structure whereas the white oxide was relatively strain free. The results indicate that a strain-induced recrystallization or fragmentation accompanies the change from protective black oxide to nonprotective white oxide. (auth)

20416 INFLUENCE OF OXYGEN ON HIGH TEMPERATURE AQUEOUS CORROSION OF IRON. W. E. Ruther and R. K. Hart (Argonne National Lab., Ill.). Corrosion, 19: 127t-33t(Apr. 1963). (ANL-FGF-358; UAC-6956)

The corrosion of pure Fe in distilled water was investigated over a range of temperature (50 to 315°C) and oxygen content of the water (<0.1 to 540 ppm). A uniform brown-black coating formed in water of low O content at 260°C. The corrosion rate was low after the initial period. Severe pitting of the Fe was encountered in water containing intermediate concentrations of O over the entire range of temperature. The average metal loss rates were also much higher than that obtained in a low O environment. A thin protective film formed when adequate O was present. The total corrosion at 30 days' exposure was lower for samples in a 260°C–540 ppm O test than for those with very little O at the same temperature. The protective film forming ability of Fe in a pitting $O-N_2O$ environment was improved by alloying, particularly with Cr and C. The thin films formed on pure Fe in adequately oxygenated H_2O were composed of α-Fe_2O_3 (hematite) as contrasted with the Fe_3O_4 (magnetite) coatings produced in deoxygenated H_2O. Distinctive growth habits for the various Fe oxides were found on the outer surfaces of the protective coatings. (auth)

20417 KINETICS AND MECHANISM OF COLUMBIUM ALLOY CORROSION IN SUPERHEATED STEAM. D. L. Douglass (General Electric Co., Pleasanton, Calif.). Corrosion, 19: 134t-45t(Apr. 1963).

Binary Nb–V alloys were studied in detail and were observed to follow initially low power rate laws varying from quartic to parabolic behavior. A rate transition occurred after longer exposures to a linear rate law that was associated with spalling and cracks in the oxide films. The corrosion product was shown to be different from that formed in air or oxygen for Nb–3.5V and was a complex unknown phase. An increase in V content to 10 at. % enabled beta-Nb_2O_5 to form with the unknown phase, and NbO_2 also formed as a third phase on Nb–15V. A change in oxide morphology was noted as V increased from 3.5 to 8.9 at. %. The activation energy for corrosion, 13 kcal/mol, was the same for binary Nb–V alloys, which formed either the unknown oxide phase or NbO_2 at temperatures below 482°C, and was considerably less than that for O diffusion in Nb_2O_5 containing 1 mole % V_2O_5. The apparent diffusion-controlled process and low corrosion activation energy strongly suggest oxide grain boundary diffusion as a rate-limiting step during the pretransition period. Oxygen contamination of the substrate occurred readily, the tolerance for O decreasing with increasing V. (P.C.H.)

20418 POLARIZATION STUDIES OF ALUMINUM ALLOYS IN WATER AT 200 C AND 300 C. J. H. Greenblatt and A. F. McMillan (Naval Research Establishment, Dartmouth, N.S., Can.). Corrosion, 19: 146t-55t(Apr. 1963).

Specimens of commercial 2S Al and two special alloys containing Fe and Ni were polarized anodically and cathodically at a number of different current densities at 200 and 300°C. Weight gains were obtained and the potentials relative to the stainless steel autoclave were measured by an interrupter method. The weight gain data indicated that the polarizing current is carried by electronic condition. The potential-time curves for anodic polarization indicate differences between 2S Al and the alloys in that greater polarization is obtained with the latter. The curves also indicate that the impressed current decreases the film resistance. In all cases the potential reached a plateau value with time, which was shorter for the alloys. Voltage current curves were also obtained on specimens left overnight (approximately 17 hours) at two different anodic polarizing currents. The curves indicated differences between 2S Al and the alloys; the differences are discussed in terms of the semiconducting properties of the oxide film. Observations made on the differences in the properties of the oxide films on the materials examined as revealed by potential and polarization curves are discussed as to their significance in determining corrosion resistance. (P.C.H.)

20419 MATERIALS OF CONSTRUCTION AND CORROSION IN THE NUCLEAR POWER INDUSTRY. C. W. Brewer (Univ. of Queensland, Brisbane). Corrosion Prevent. Control, 9: 27-37(Sept. 1962).

The nature of nuclear reactions and the various types of reactors (gas-cooled, pressurized water, and fast breeder) are discussed. The corrosion of steel in water is considered, and corrosion problems in the different reactor types are discussed. (D.L.C.)

20420 THE ROLE OF MOLYBDENUM IN CORROSION-RESISTANT MATERIALS. [PART] II. Corrosion Prevent. Control, 9: 43-8(Dec. 1962).

Upper resistance limits of two stainless steels and a Ni–Mo alloy in H_2SO_4 are compared. Zr alloys containing 0.5 to 1.5% Mo and 0.5 to 1% Cu were found to be corrosion-resistant to CO_2 and steam, as compared with Zr and Zircaloy-2. Data are plotted for the corrosion resistance of Mo metal under very severe corrosion conditions as compared with other metals. Mo is shown to have excellent resistance to many liquid metals. The Mo–30% W alloy is discussed briefly. (D.L.C.)

20421 THE PRESENT STATE OF OUR KNOWLEDGE ON CORROSION. Jacques Benard (Faculté des Sciences, Paris). Ind. At., 7: 47-54(1963). (In French)

Corrosion studies have been confined for a long time in empiricism because of the complexity and multiplicity of factors coming into play. At the present time it has become possible to analyze scientifically these factors by using delicate methods of study such as electron diffraction, radioisotopes, and ultramicrogravimetry. The science of surface states has simultaneously made great progress and permits experiments to be made with excellent conditions of reproduction. As an example, recently acquires progress in the domain of dry corrosion of metals and alloys is reviewed. (tr-auth)

20422 CORROSION OF ZIRCONIUM AND ITS ALLOYS BY GASES AT HIGH TEMPERATURES. Raymond Darras (CEA, Paris). Ind. At., 7: 55-65(1963). (In French)

After a review of the principal properties of Zr, chiefly

in the nuclear realm, the consequences of its high reactivity with various ordinary gases—hydrogen, oxygen, nitrogen, air, and carbon dioxide—at average or high temperature are examined using the principal bibliographic data. The poor chemical compatibility of the metal with all these atmospheres was thus shown. The possible improvements offered by some experimental alloys, chiefly alloys containing several per cent copper, are indicated. These alloys can be used for a long time in carbon dioxide under pressure up to 600°C. (tr-auth)

20423 CORROSION BY URANIUM HEXAFLUORIDE. L.-M. Vincent, J. Dixmier, and R. Hasson (CEN, Saclay, France). Ind. At., 7: 67-80(1963). (In French)

Although corrosion by uranium hexafluoride is a phenomenon of great economic importance, the penetrations measured in numerous metals are on a scale not used in industrial corrosion. The systematic measurement of such corrosion demands the establishment of special methods. The results of corrosion experiments are examined with respect to the corrosion kinetics, figures, and products. The metallurgical factors involved such as metal structure, purity, and surface conditions are also considered. The classifications obtained are related to the Mendeleev table. The effect of external factors is indicated. (tr-auth)

20424 INFLUENCE OF DIFFERENT FACTORS ON THE CORROSION OF MAGNESIUM IN DEMINERALIZED WATER. J. Blanchet, H. Coriou, L. Grall, M. Pelras, G. Plante, and M. Salesse (Centre d'Etudes Nucléaires, Saclay, France). J. Nucl. Mater., 7: 311-19(Dec. 1962). (In French)

A systematic study was undertaken on the aqueous corrosion of Mg and certain of its alloys. It was found that the purity of the metal plays an important role, the details of which depend upon the composition of the H_2O. Pure Mg is superior to commercial Mg in chlorinated H_2O, but may suffer deep attack in demineralized H_2O. This attack is of a specific nature, different from classical intergranular attack. Oxygen dissolved in demineralized H_2O has no influence on the corrosion of Mg between 20 and 130°C. Among different inhibitors that were examined only the alkali fluorides were efficacious in demineralized H_2O. However, they did not prevent the deep attack on pure Mg. The influence of chloride ions on the corrosion of Mg was studied by obtaining polarization curves. The role of chloride ions was brought out clearly, and it was possible to establish tolerance limits for the ions. (auth)

20425 NOTE ON THE TOPOGRAPHY OF THE OXIDE FILMS FORMED ON ALUMINUM IN HIGH TEMPERATURE WATER. J. H. Greenblatt and T. P. Copps (Naval Research Establishment, Dartmouth Nova Scotia, Can.). J. Nucl. Mater., 7: 328-43(Dec. 1962). (In English)

A topographical study was made of the oxide film formed during the early stages of corrosion on two Ni- and Fe-containing Al alloys and 2S Al. The results give additional evidence that irregular features on the oxide film surfaces are related to the presence and type of second phase particles, and it is shown that irregularities develop during the early stages of corrosion and film formation. By correlating the topography of the oxide films with the information obtained by examining cross sections, the results show the specific role the second phase particles play in influencing topography. (P.C.H.)

20426 THE OXIDATION AND CORROSION OF NIOBIUM (COLUMBIUM). Brian Cox and Tom Johnston (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Trans. AIME, 227: 36-47(Feb. 1963). (NP-12029)

The results of oxidation and corrosion experiments on niobium in oxygen and steam at temperatures of 350 to 650°C, and in dilute sulfate solutions at 300°C are presented. The oxidation of niobium in oxygen can be explained in terms of a pretransition period, which obeys an approximately parabolic rate law, and a post-transition period in which a more rapid linear rate is partially stifled by restriction of the gas flow due to the growth of the porous outer film. In water vapor the oxidation of niobium follows a parabolic rate law and does not show a transition to linear kientics. The higher oxide, Nb_2O_5, was usually absent from the NbO/NbO_2 film which was formed. The addition of a small partial pressure of oxygen to the water vapor resulted in accelerated oxidation according to the normal kinetics for oxidation in oxygen. The theory that nucleation of Nb_2O_5 on the surface of the protective NbO/NbO_2 film is the cause of the accelerated oxidation was supported. After oxidation in steam at high-pressure Nb_2O_5 was found in the protective film. The kinetics of oxidation in oxygenated aqueous solutions at 300°C were similar to those for oxidation in oxygen. (P.C.H.)

20427 ETCH PITS IN URANIUM MONOCARBIDE. Cecil G. Rhodes (Atomic International, Canoga Park, Calif.). Trans. AIME, 227: 286-8(Feb. 1963).

A technique for producing etch pits in uranium monocarbide was developed and is described. The pits, which are assumed to be associated with dislocations, appear individually and as arrays delineating sub-boundaries. The etchant used was concentrated H_3PO_4. Evidence to support the assumption that the pits are associated with dislocations is given. (P.C.H.)

20428 IMPROVEMENTS IN OR RELATING TO THE INHIBITION OF THE CORROSION OF METALS BY STEAM AT HIGH TEMPERATURES. John Nelson Wanklyn and Colin Frederick Britton (to United Kingdom Atomic Energy Authority). British Patent 922,707. Apr. 3, 1963. Filed Dec. 9, 1960.

A method for inhibiting the corrosion of metals by dry steam at super-atmospheric pressures is described which comprises the introduction of boric acid or borosilicate glass into the steam. In the use of steam as reactor coolant, the boron in the boric acid should be at least 99% B^{11}. Examples of such inhibition are given in which Zr, Zircaloy-2, Al, and Be are used. (D.L.C.)

Fabrication

Refer also to abstracts 21232 and 21233.

20429 (AD-294774) DEVELOPMENT OF AUTOMATIC QUALITY CONTROL FOR RESISTANCE WELDS IN ALUMINUM ALLOYS. PHASE II. MODIFICATION OF CIRCUITRY AND EVALUATION OF A FEEDBACK WELD CONTROL FOR RESISTANCE SPOT WELDING ALUMINUM ALLOYS. Richard P. Hurlebaus (Budd Co. Materials Research Lab., Philadelphia). Nov. 20, 1962. Contract DA 36-034-ORD-3217 RD. 114p.

An analysis was made of data on constant electrode voltage, constant weld current, and weld zone resistance change to determine the selection of three principles for weld feedback control of resistance spot welding of aluminum alloys. The latter principle proved to be the most reliable signal for a feedback system. The weld control circuits for a single phase feedback system were modified to produce a laboratory working model of a control for the

three-phase welding machine. The necessary circuits were built in "breadboard" fashion and bench tested for continuity of signal. All circuits were integrated into a control system to be evaluated by resistance spot welding chemically cleaned 0.051", 5456H343. The weld tests indicated the feedback control corrected for changes in the weld zone resistance, as the weld zone resistance decreased with the weld growth or development. This was in accordance with the correlation that as the weld grew larger the weld zone resistance decreased in a predictable and reliable manner. The weld control system performed satisfactorily during the tests to maintain weld size and strength during a qualification-type weld test. The control system has desirable benefits as it provides an in-process control over the weld nugget development. (P.C.H.)

20430 (AD-299397) INVESTIGATION OF ULTRASONIC WELDING OF REFRACTORY METALS AND ALLOYS. Bimonthly Progress Report No. 2, October 16–December 16, 1962. (Aeroprojects, Inc., West Chester, Penna.). Jan. 1963. Contract NOw 63-0125-c. 15p.

The programming of ultrasonic welding power is shown to be straightforward. Similar control of clamping force involved employment of various hydraulic circuitry prior to achievement of acceptable response time. Use of an alternate valve component in the hydraulic system is to be investigated for result comparison purposes. Problems relative to establishment of specifications for quality refractory metals are mentioned. (auth)

20431 (ATL-A-126) DEVELOPMENT OF CLAD CERAMIC FUEL PLATES BY SPRAY-COATING TECHNIQUES. Final Report, Phase I. N. E. Weare (Advanced Technology Labs. Div. of American Standard, Mountain View, Calif.). Oct. 31, 1961. Work Performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 104p. (EURAEC-439)

Activities in a program to develop techniques of plasma spraying clad plate-type UO_2 fuel elements are reported. The investigation was also directed toward determining the limitations of the process as applied to fuel element fabrication. UO_2 powder coatings having densities of 90% theoretical were produced. At conditions required for spraying plates, densities of 86% appear to be practical. The rate and efficiency of UO_2 coating deposition were also determined for various spraying conditions. Gritblasting was found to provide the best surface for coating adherence. The O/U ratio of the UO_2 was maintained by spraying in an Ar atmosphere. Zircaloy-2 was found to be the most desirable cladding material. Cladding thicknesses of 0.035 in. are required in distortion-free 2-in.-wide plates. (J.R.D.)

20432 (BRB-71) DYNAPAK EXTRUSION OF MARK V-B OUTER FUEL ELEMENT CORES. Report No. 1. Q. C. Carloni and L. Lewis (Bridgeport Brass Co., Seymour, Conn.). Mar. 25, 1963. Contract AT(30-1)-1405. 46p.

Initial activity to produce a Mark V-B outer element by high energy rate extrusion techniques is described. Difficulties with mandrel breakage were overcome through redesign of the part. Metallurgical characteristics, while varying from extrusion to extrusion, showed promise of being able to conform to strict requirements for this element. Areas which still require development include closer dimensional control and the effecting of a uniform beta phase structure across the length of the extrusion. (auth)

20433 (HW-69680) RECOVERY AND RECRYSTALLIZATION OF ZIRCONIUM AND ITS ALLOYS. PART 3. ANNEALING EFFECTS IN ZIRCALOY-2 AND ZIRCALOY-3. S. H. Bush and R. S. Kemper (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). May 1961. Contract AT(45-1)-1350. 62p.

Reactor-grade Zircaloy-2 and vacuum-melted Zircaloy-3V were prepared by arc melting twice under vacuum. In addition, argon-melted Zircaloy-3A was prepared by arc melting in a vacuum and then under Ar. The materials were rolled into plate. Specimens of the same thickness and having the same penultimate grain size were prepared at cold work levels of 10, 25, and 50%. The specimens were annealed at 300, 400, 500, 600, 700, and 800°C at 10, 100, 1000 and, in some instances, 10000 min in air, He, and vacuum (10^{-4} to 10^{-5} mm Hg) atmospheres. Recovery, recrystallization, and grain growth as a function of cold work level, composition, annealing time, temperature, and atmosphere were studied by hardness and electric resistivity measurements, and by metallographic observations. Recovery and secondary hardening were observed at temperatures of 300 to 500°C. Recrystallization began at 500°C and was essentially complete at 600°C after 1000 min or less. Recrystallization occurred by subgrain growth in material cold worked 10%. Conventional nucleation and growth occurred at 25 and 50% cold work. Definite differences in response to annealing atmosphere were observed. Vacuum-annealed alloys recrystallized more slowly than air- or He-annealed alloys. (auth)

20434 (NLCO-863) ROTARY ELONGATION OF URANIUM TUBING. R. B. Steck and H. W. Hesselbrock (National Lead Co. of Ohio, Cincinnati). Apr. 16, 1963. Contract AT(30-1)-1156. 75p.

One hundred twenty-eight U tubes were rotary elongated successfully on a No. 1 Witter mill. The test was performed on a small, shell-rolling mill which utilized the same three-roll rolling principle now in use in the Assel-type seamless tube mill. Feed stock for the test was supplied by extrusion and by centrifugal casting. Billets were preheated in a gas-fired muffle furnace and were protected by a continuous flow of Ar. Evaluations were made of billet preheat temperature, mandrel heating, roll cooling, roll design, roll speed, feed angle, grain structure, and type of feed-stock. Slippage problems encountered in previous tests were corrected by roll design modifications, a reduction in roll rotational speed, and an increase in feed angle. (auth)

20435 FABRICATION OF POROUS TUNGSTEN IONIZERS BY MEANS OF VAPOR PLATING. E. Mark Gold (Unified Science Associates, Pasadena, Calif.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 695-6(Mar. 1963).

The feasibility was demonstrated of an original method of constructing the porous tungsten ionizer-manifold assembly used to ionize cesium for ion propulsion. It is accomplished by fabricating a tungsten manifold directly on, and integral with, the porous tungsten. The manifold is produced by vapor plating a nonporous tungsten film from a gaseous tungsten compound. (auth)

20436 FABRICATION OF FUEL PLATES FOR BOILING WATER REACTORS. Ignacio Frisancho Pineda. Bol. Inform. Junta Control Energ. At. (Peru), 7: 8p.(1962). (In Spanish)

One of the simplest methods for the fabrication of fuel elements of the plate type used in boiling water reactors is described. The fuel alloy contains 90% U and 5% Zr. The ultrasonic and x-ray methods for the quality control of the fuel plates are discussed. (J.S.R.)

20437 SINTERING STUDIES OF MOLYBDENUM-COATED URANIUM DIOXIDE PARTICLES. H. S. Gadiyar

and J. Balachandra (Atomic Energy Establishment, Trombay, India). Indian J. Technol., 1: 162-4(Apr. 1963).

Compacts of Mo-coated UO_2 with a density 93 to 95% of the theoretical were prepared by vapor phase deposition of Mo on UO_2 particles of 100 to 150-μ size at 700°C for 2 hr, and then cold pressing the coated particles at 32 tons/in.^{2} and sintering the resulting pellets in dry H atmosphere at 1500°C for 5 hr. In their bulk density and porosity, the pellets of Mo-coated UO_2 obtained under the above conditions compared favorably with pellets of a mixture of Mo and UO_2 particles. (auth)

20438 SUPERCONDUCTING MAGNETS. J. K. Hulm, B. S. Chandrasekhar, and H. Riemersma. Intern. Sci. Technol., No. 17: 50-7(May 1963).

Magnet-wire superconductors differ from ordinary superconductors in their transition from the superconducting to the nonsuperconducting state. They do not switch all at once when exposed to magnetic fields, but change first to a partially superconducting state. Enough superconductivity remains at fields of 100 kilogauss or more to sustain a very large current. Making magnets from these materials was fraught with difficulties. The metals are hard and brittle and very difficult to handle. Currents were much less than expected from laboratory tests. For some reason coils of wire do not perform as well as short pieces. And ways must be found to protect the coil from the energy released when it accidentally returns to the resistive state while carrying current. Fields in the tens of kilogauss are now attainable. (auth)

20439 SUPERCONDUCTING Nb_3Sn STRIP. A. C. Barber and P. H. Morton (Imperial Metal Industries (Kynoch), Ltd., Birmingham, Eng.). Nature, 198: 82 (Apr. 6, 1963).

A method is described for making short lengths of Nb_3Sn in strip form. Conductivity tests on short lengths of the material showed them to remain superconducting up to a current of 130 amp in a field of 78 kgauss at 4.2°K. (C.K.)

20440 PROCESS FOR THE PRODUCTION OF ROLLED ARTICLES FROM THORIUM-CONTAINING MAGNESIUM ALLOYS. (to Dow Chemical Co.). British Patent 920,454. Mar. 6, 1963. Priority date July 9, 1959, United States.

The heat treatment at temperatures above 370°C of Mg–Th alloys (Th ~0.5 to 3 wt %) in preparation for hot rolling of sheet, usually results in a roll pickup which is insoluble in acetic acid-sodium nitrate pickle and other acid pickles. The problem can be solved by carrying out the heat treatment in an atmosphere containing at least 10 vol % water vapor, preferably 20 vol %. Several examples of this solution are given. (D.L.C.)

20441 METHOD OF TREATING ZIRCONIUM ALLOYS. (to Wah Chang Corp.). British Patent 923,212. Apr. 10, 1963. Priority date Apr. 10, 1961, United States.

A method is outlined for fabricating Zircaloy so that it has uniformly high corrosion resistance. The method comprises subjecting Zircaloy in the beta temperature range (1800 ± 50°F), quenching it to a temperature below the alpha-beta range (<1550°F), and subjecting it to a temperature above the recrystallization temperature and within the alpha range (1100 to 1500°F) while working it to reduce its cross section by at least 30%. (D.L.C.)

20442 EXTRUSION DIE FOR MAKING CARBON NEUTRONIC REACTOR CORE BARS. (to Great Lakes Carbon Corp.). British Patent 923,672. Apr. 18, 1963. Priority date Feb. 9, 1961, United States.

An extrusion die for making green carbon bars for subsequent graphitization and use as reactor moderator bars is described which controls the orientation of carbon crystallites during the extrusion. The die is provided with a rectangular inlet and a rectangular outlet, and one dimension of the inlet is the same as the corresponding dimension of the outlet, while the other dimension of the inlet is from 2 to 5 times larger than the corresponding dimension of the outlet. Two embodiments of the die are described. (D.L.C.)

20443 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. John Alexander Dukes (to United Kingdom Atomic Energy Authority). British Patent 923,675. Apr. 18, 1963. Filed Mar. 10, 1960.

Beryllium, in order to be usable as a sheathing material for fuel elements, should not contain more than 0.5 ppm of uranium. However, a fuel element sheath made of beryllium containing a large amount of uranium impurity can still be used if it is coated with a ≥15-μ-thick deposit of beryllium containing less than 0.5 ppm beryllium. The coating preferably is deposited by a vacuum deposition process. (D.L.C.)

20444 HARD-SOLDERING METHOD, PARTICULARLY FOR JOINING NUCLEAR-REACTOR COMPONENTS. Wolfgang Roessner (to Siemens-Schuckertwerke Aktiengesellschaft). U. S. Patent 3,085,141. Apr. 9, 1963. Priority date July 2, 1959, Germany.

A method is given for producing strong hard-solder joints between structural metal components, even though the solder and one of the base materials tend to form an embrittling transition. The method comprises providing one of the two components with a fast-adhering coating of solder material under non-reactive conditions, heating the other component to above the melting point of the solder, and then placing the heated component in contact with the cold solder-coated component. This method limits the amount of brittle texture formed between the solder layer and the cold component. (D.L.C.)

20445 FUEL ELEMENT FOR AN ATOMIC REACTOR. Jacques André Stohr and Maurice Gauthron (to Commissariat à l'Énergie Atomique). U. S. Patent 3,085,954. Apr. 16, 1963. Priority date July 7, 1958, France.

A method is given for producing sheathed reactor fuel elements which have reduced sheath thickness and increased heat transfer properties. The method comprises forming a series of fuel pellets in which the diameter of alternate pellets is greater than that of the other pellets, enveloping the pellets in a sheath, and deforming the sheath to form corrugations. Longitudinal folds may also be formed in the sheath. (D.L.C.)

Properties and Structure

Refer also to abstracts 20150, 20151, 20152, 20969, 20970, 20971, 20972, 20973, and 20979.

20446 (AD-284284) DEFORMATION PROCESSES IN MATERIALS. Final Report. J. Washburn, E. R. Parker, and R. F. Tinder (California. Univ., Berkeley. Materials Research Lab.). Aug. 1962. Contract Nonr-222(52). 187p.

It was found that irreversible plastic deformation occurs in polycrystalline specimens of zinc, copper and its dilute alloys, and aluminum at room temperature, beginning at stresses indetectably above zero applied stress. Neither Frank-Read source generation nor simple bowing of dislocations between fixed nodes can explain the irreversible plastic behavior observed at small stresses in the metals studied. More extensive rearrangements of the disloca-

tion substructure that probably involve glide of nodes and formation of new nodes seem to be required. Prestrained specimens of copper and its dilute alloys often exhibited bursts of plastic deformation which could possibly be due to cooperative rearrangement of the dislocation substructure in one or a few grains. The introduction, by particle bombardment, of new lengths of dislocations into the gage section surface of specimens of copper and its dilute alloys produced extensive irreversible plastic flow beginning at stresses indetectably above zero applied stress. The effect of prestrain on the shape of the loading and unloading curves for zinc shows that dislocation rearrangements that cause forward and reverse strain can occur simultaneously. The net strain rate can be the algebraic sum of the strain recovery rate and the forward creep rate. The present quantitative theories of the Peierls-Nabarro stress are insufficient to permit an estimate of its magnitude from the results of this investigation. In dilute copper alloys containing up to 0.1 at. % impurity, there were many dislocations in the grown-in networks that were not locked by segregation of the foreign atoms. The study of creep behavior over a range of temperatures and at the same strain sensitivity used in these experiments combined with dislocation etch pit observations of dislocation substructure appears to be a particularly fruitful field for further investigation. (auth)

20447 (AD-286443) STACKING FAULTS IN SILVER–LITHIUM ALLOYS. Technical Report No. 5. R. C. Sundahl and J. M. Sivertsen (Minnesota. Univ., Minneapolis. Inst. of Tech.). June 29, 1962. Contract Nonr 710(29). 15p.

Stacking fault probabilities (densities) were determined in the Ag–Li system as a function of atom fraction of Li in the alloys. An observed decrease in stacking fault energy was just as expected owing to the large difference in the electronegativity of Ag and Li. (P.C.H.)

20448 (ATL-A-133) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Progress Report No. 3, July–September 1962. K. E. Horton (Advanced Technology Labs. Div. of American Standard, Mountain View, Calif.). Work performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-250. 33p. (EURAEC-481)

The thermal-stress-fatigue testing of Types 304 (0.05% C) and 304-L (0.018% C) stainless steels is discussed. Prior to the actual testing, the existing machines were upgraded in performance capability, and additional electronic equipment for measuring the test variables was installed. The majority of specimens tested to date were of Type 304 stainless steel. These tests were run at a rate of temperature change equivalent to a strain rate of 0.005 in. per in. per sec. Mean temperatures of 400, 500, and 600°C are being used in conjunction with temperature changes of sufficient magnitude to ensure low cycles-to-failure fatigue lives. Emphasis is being placed on metallographic examination of failure regions, in an effort to ascertain the morphology of fatigue failure. Results to date have not revealed striking differences among specimens tested under different conditions. (auth)

20449 (ATL-A-134) INVESTIGATION OF THERMAL-STRESS-FATIGUE BEHAVIOR OF STAINLESS STEELS. Quarterly Progress Report No. 4, October–December 1962. K. E. Horton and R. S. Stewart (Advanced Technology Labs. Div. of American-Standard, Mountain View, Calif.). Work performed under United States–Euratom Joint Research and Development Program. Contract AT (04-3)-250. 41p. (EURAEC-555)

The thermal-stress-fatigue and strain-cycling-fatigue testing of Types 304 and 304-L stainless steels are discussed. The test variables included atmospheric surroundings, hold time, specimen size, and mean temperature. Results indicated a significant difference in fatigue life between annealed and cold-worked material. No significant difference in fatigue life resulted from testing in argon as opposed to air. Metallographic structural analysis showed the effects of strain softening as well as various modes of plastic deformation. Emphasis is placed on the metallographic examination of fatigued specimens. (auth)

20450 (BBC-116) DEVELOPMENT OF INTERMETALLIC COMPOUNDS FOR VERY HIGH TEMPERATURE APPLICATIONS. Summary Technical Report, January 1, 1962 through August 31, 1962. R. M. Paine, J. Booker, A. J. Stonehouse, and W. W. Beaver (Brush Beryllium Co., Cleveland). Nov. 30, 1962. Contract AT(33-3)-20. 85p.

Investigations of the intermediate-temperature problems, particularly those of oxidation, of the zirconium and niobium beryllides are discussed. The primary emphasis of the work was on additives to these compounds to promote intermediate-temperature oxidation resistance. Aluminum and NiAl additions to $ZrBe_{13}$ completely eliminate accelerated oxidation of this compound at intermediate temperatures (1100 to 1700°F). Some of this work was extended to other beryllides: Zr_2Be_{17}, $NbBe_{12}$, and Nb_2Be_{17}. Silicon additions to $ZrBe_{13}$ also appeared promising, but additions of tin and platinum were ineffective in promoting oxidation resistance at the critical intermediate temperatures. Studies involving the mechanism of intermediate-temperature failure, and particularly the effect of additives, are included. Thermal expansion coefficients for UBe_{13} and Nb_2Be_{19} are given. (auth)

20451 (BBC-117) RESEARCH ON MODIFIED BERYLLIDES AS HIGH-TEMPERATURE NUCLEAR MATERIALS. Quarterly Progress Report, September 1, 1962 through November 30, 1962. R. M. Paine, A. J. Stonehouse, and W. W. Beaver (Brush Beryllium Co., Cleveland). Dec. 31, 1962. Contract AT(33-3)-20. 16p.

Addition of aluminum to niobium zirconium beryllides was found to eliminate the poor oxidation resistance of these compounds at 1300–2000°F. An attempt was made to improve the high temperature (2000–2700°F) strength of $ZrBe_{13}$ which contained Al. Presence of elemental Al at the grain boundaries weakened the compound, but addition of small amounts of Zr_2Be_{17} increased high temperature strength. Studies of Al solubility in these compounds and of additive agents other than Al are being made. (D.C.W.)

20452 (BSD-TDR-63-62) THE UPPER CRITICAL FIELD OF Nb–Zr AND Nb–Ti ALLOYS. A. El Bindari, and M. M. Litvak (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Jan. 1963. Contract AF04(694)-33. 8p. (AD-299781; AMP-101)

The upper critical field of Nb–25% Zr was found to be 6 ± 1 kg at 4.2°K and 28 ± 1 kg at 4.2°K for Nb–10% Ti. The relation between critical temperature, electronic heat capacity, and electric conductivity in the equation used are discussed. (P.C.H.)

20453 (CRGM-1135) THE EFFECT OF STRAIN ON THE DIRECTIONAL PRECIPITATION OF ZIRCONIUM HYDRIDE IN ZIRCALOY-2. G. W. Parry and W. Evans (Atomic Energy of Canada Ltd., Chalk River, Ont.). Dec. 1962. 20p. (AECL-1707)

The occurrence of directional zirconium hydride precipitation in several Zircaloy-2 components led to a belief that precipitation in this manner was caused by prior strain

such as the fabrication techniques. It was demonstrated that zirconium hydrides precipitate parallel to the direction in which the grains are deformed and that the amount of directionality increases with increasing strain and with heat treatment temperature up to 600°C. No directionality was observed at strains below 7%. Annealing treatments did not destroy directionality. Experiments on directionality are described and also the occurrence of the effect in a number of fabricated Zircaloy components. (auth)

20454 (D3-4657) EVALUATION OF CADMIUM PLATING SYSTEMS FOR HYDROGEN EMBRITTLEMENT. Theodore G. Kozan (Boeing Co. Military Aircraft Systems Div., Wichita, Kan.). Sept. 19, 1962. 83p.

A coöperative testing program to compare the hydrogen embrittlement characteristics of several available plating systems was conducted. Eleven plating systems that showed promise of being nonembrittling were selected for evaluation. The plating systems evaluated approached the problem of reduction of hydrogen entry and/or subsequent removal from steel by: porous deposits and subsequent baking to remove and/or distribute hydrogen absorbed; high efficiency (low hydrogen producing bath) with subsequent baking; suppression of hydrogen formation by additives; organic baths with no hydrogen formation; and organo brush plating baths. The 0.003-inch notch root radius tensile specimen and the ring specimen evaluated previously were selected to test and evaluate the plating systems. The same heat of material was used for fabricating test specimens. The test grips and the alignment procedure for the sustained load notched tensile test were shown to produce the specified minimum bending stress. The cadmium plating of ring and notched tensile specimens for evaluation of the individual plating systems was identical insofar as possible. The sustained load notched tensile test appeared to be more sensitive to the relative degree of hydrogen embrittlement than the stressed ring test. The plating systems evaluated by both test methods were grouped for comparison and results are presented. (auth)

20455 (HW-75654) SONIC DETERMINATION OF ELASTICS CONSTANTS IN GRAPHITE. D. E. Cooley (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 13, 1962. Contract AT(45-1)-1350. 37p.

The operation of a Magnatest Type FM-500 Elastomat instrument, the detection and recognition of the resonant frequencies of a sample, the methods and formulas for the calculation of the elastic moduli from the resonant frequencies, and results obtained from testing several different materials and sample shapes are discussed. The accuracy and reproducibility of the sonic modulus method for graphite was found to be very good. The fundamental flexural resonance was reproducible to within 0.2%, with the reproducibility of the high resonances decreasing to about 0.5%. The data are tabulated. (P.C.H.)

20456 (NYO-9437) SELF-DIFFUSION IN α-IRON DURING COMPRESSIVE PLASTIC FLOW. Report No. 3. Ken-ichi Hirano, Morris Cohen, B. L. Averbach, and N. Ujiiye (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Apr. 18, 1963. Contract [AT(30-1)-2879]. 36p.

The influence of plastic deformation in compression on the self-diffusivity of α-iron was measured in the temperature range 742 to 885°C. The diffusivity was enhanced in proportion to the strain rate, but the dependence decreased with increasing temperature. The magnitude of the strain is relatively unimportant in this connection. Strain rates from 0 to -2×10^{-3} sec^{-1} were investigated, with a corresponding increase in diffusivity up to 3×10^3 times. The results were analyzed in terms of vacancy diffusion and the excess vacancies introduced during deformation. It was concluded that grain boundaries are the main vacancy sinks in polycrystalline iron and that the vacancy lifetime is therefore dependent on the grain size. A typical vacancy lifetime at 800°C with a mean grain-boundary intercept of 0.3 cm is of the order of 1 sec. (P.C.H.)

20457 (NYO-9438) DIFFUSION OF IRON, COBALT, AND NICKEL IN SILVER. Report No. 4. Ken-ichi Hirano, Morris Cohen, and B. L. Averbach (Massachusetts Inst. of Tech., Cambridge. Dept. of Metallurgy). Apr. 18, 1963. Contract AT(30-1)-1975. 15p.

Diffusion coefficients of Fe, Co, and Ni in Ag were determined over the temperature range 600 to 850°C using radioactive tracers and the residual-activity technique. The results, (in units of cm^2/sec), are: $D_{Fe/Ag} = 9.4 \times 10^{-7} \exp(-29{,}600/RT)$, $D_{Co/Ag} = 3.0 \times 10^{-7} \exp(-29{,}700/RT)$, and $D_{Ni/Ag} = 8.5 \times 10^{-7} \exp(-28{,}700/RT)$. The frequency factors and activation energies were quite small relative to those for self-diffusion in Ag. It appears that the extremely low solid solubilities of Fe, Co, and Ni in Ag reduce the flux through the lattice to the point where diffusion along dislocation short-circulating paths becomes the controlling mechanism. (auth)

20458 (TID-16413) TRANSMISSION ELECTRON MICROSCOPY OF URANIUM. C. L. Angerman (Du Pont de Nemours (E. I.) & Co. Savannah River Lab., Aiken, S. C.). [Aug. 1962]. Contract AT(07-2)-1. 6p.

A technique for the thinning of U for transmission electron microscopy is described. The main difficulty was the removal of the anodic film that formed during electropolishing. However, excellent electroplating results were obtained with a solution of 800 cc ethanol, 500 cc ethylene glycol, and 500 cc H_3PO_4 (85%) with the U cathode at 30 ma/cm^2 and room temperature. The anodic film that formed was then removed by electropolishing in a solution composed of 75 cc H_2SO_4 (98%), 7cc H_2O, and 18 cc glycerol with a Pt cathode at 6 v between 0 and 5°C. Examples of the structures that were seen in samples prepared in the solutions by the window technique are illustrated. (P.C.H.)

20459 (TID-18480) ELECTRON MICROSCOPY OF SINTERED BERYLLIA. Robert C. Rau (General Electric Co. Flight Propulsion Lab. Dept., Cincinnati). [1962]. Contract AT(40-1)-2847. 24p. (TM-62-10-15)

Supersedes TM-62-8-16.

Porosity, etching characteristics, and general microstructural features of extruded and sintered beryllium oxide were studied by means of electron microscopy. Replicas were prepared from as-polished, polished and ultrasonically cleaned, polished and etched, and fractured surfaces. The techniques used in preparing and replicating the surfaces are presented together with typical electron micrographs of the structures observed. Both pore structures and etching characteristics were shown to have a relation to the hemimorphic hexagonal crystal structure of BeO. A form of twinning possible only in hemimorphic systems was also observed. (auth)

20460 (UCRL-7184) AN INVESTIGATION OF INTERSTITIAL SITES IN THE BCC LATTICE. Daniel N. Beshers (California. Univ., Livermore. Lawrence Radiation Lab.). Jan. 4, 1963. Contract W-7405-eng-48. 32p.

Two geometrically different positions are available in the body-centered cubic structure for the formation of

interstitial solid solutions. In order to determine which of the two sites is energetically favored, relative values of the strain energy were calculated for interstitial atoms of varying size. It was found that in some cases, notably in the group V-A elements, the tetrahedral rather than the octahedral sites are favored. Estimates of the energies of activation for diffusion based upon similar calculations of the associated strain energies are also presented. It was found that in some cases elementary diffusion jumps connecting tetrahedral sites are preferred to those linking octahedral positions. An analysis was also made of the relaxation strength associated with the tetrahedral position. It was found to be smaller than that associated with the octahedral position but sufficiently large to account for several measured values. (auth)

20461 THE CRYSTAL STRUCTURE OF Th_3Pd_5 AND Th_3Pt_5. J. R. Thomson (Imperial Coll. of Science and Tech., London). Acta Cryst., 16: 320-1(Apr. 10, 1963).

The film of the alloy of 63 at. % Pd was indexed as hexagonal with a = 7.149 ± 0.003 Å, c = 3.899 ± 0.002 Å, c/a = 0.545; observed and calculated values of $\sin^2\theta$ are tabulated. The volume of the unit cell suggested that the compound was Th_3Pd_5 with one unit of Th_3Pd_5 per unit cell and a calculated density of 11.84 g cm^{-3}. Examination of an alloy containing 63 at. % Pt suggested that the Th_3Pt_5 was isostructural with Th_3Pd_5, and $\sin^2\theta$ values corresponding to a = 7.162 ± 0.003 Å, c = 3.908 ± 0.002 A, c/a = 0.546 gave good agreement with observed values. Interatomic distances for Th_3Pd_5 also are given. (P.C.H.)

20462 TEMPERATURE VARIATION OF FLOW STRESS IN BODY CENTERED CUBIC METALS. D. P. Gregory (Pratt and Whitney Aircraft, Middletown, Conn.). Acta Met., 11: 455-61(May 1963).

Results of rate theory and electrical resistivity studies with electron beam-melted polycrystalline Nb suggest that the temperature variation of flow stress for Nb containing several hundred ppm interstitial impurities is governed by nonconservative motion of vacancy jogs in screw dislocations in the temperature range 0 to 900°C. The resistivity study indicates that vacancies are released from trapping sites and become mobile at 167°C. The height of the total energy barrier is found to be roughly 3.3 ev below 167°C and 4.1 ev above 167°C. The experimental results below 167°C are interpreted in terms of Seeger's mechanism of formation of vacancies by conservative plus nonconservative motion of jogs in screw dislocations which requires the energy to form lattice vacancies, near 3.3 ev for Nb. The additional energy above 167°C is interpreted as that required to diffuse the vacancy away from the jog so that the total energy is equal to that for self diffusion, near 4.1 ev for Nb. The temperature region just above 167°C in which the stress is relatively insensitive to temperature is interpreted as a transition between the two mechanisms and not due to Snoek ordering. (auth)

20463 ANOMALIES OF REACTIVITY OF Fe–Al AND Co–Al ALLOYS AT THE CURIE POINT OF THE MAGNETOGENIC METAL. Marc Daire and Jacqueline Boissier (Université, Strasbourg). Compt. Rend., 256: 1099-1102 (Jan. 28, 1963). (In French)

The oxidation velocity of alloys having the composition Fe–Al and Co–Al pass through a maximum at the Curie points of iron and cobalt, respectively. Thermomagnetic analysis and electron microdiffraction show the presence of free magnetogenic metal. (tr-auth)

20464 PLASTIC DEFORMATION OF IMPERFECT MONOCRYSTALS OF α URANIUM BY CREEP ABOVE 550°C. Jean-Pierre André and Pierre Grenier (École des Mines, Paris). Compt. Rend., 256: 1511-13(Feb. 11, 1963). (In French)

The creep of monocrystals of α uranium above 550°C occurs essentially by slip. The heat of activation for the creep is higher than that found for polycrystals. An explanation is proposed with respect to the stability of the polygonization of crystals pre-existent to the creep. This was due to their mode of growth by $\beta \rightarrow \alpha$ phase transformation. (tr-auth)

20465 DETERMINATION OF THE ACTIVITY OF COPPER IN LIQUID ALUMINUM–COPPER ALLOYS AT 1100°C. Étienne Bonnier, Pierre Desre, and Ibrahim Ansara (École Nationale Supérieure d'Électrochimie et d'Électrometallurgie, Grenoble, France). Compt. Rend., 256: 1524-7(Feb. 11, 1963). (In French)

The activity of Cu at 1100°C in liquid Al–Cu alloys is determined by the study of the partition of this element between immiscible liquid metallic phases of Al–Pb and Al–Bi alloys. A corrective calculation was made in order to take into consideration the reciprocal solubilities of the solvent metals and their variations as a function of the concentration of the partitioned element. (tr-auth)

20466 NEUTRON DIFFRACTION STUDY OF $Fe_{0.47}Rh_{0.53}$. Félix Bertaut, Francois de Bergevin, and Georges Roult (Laboratoire d'Électrostatique et de Physique du Métal, Grenoble, France and CEN, Grenoble, France). Compt. Rend., 256: 1688-91(Feb. 18, 1963). (In French)

Fe–Rh alloys in the vicinity of equiatomic composition pass from a nonmagnetic state to a ferromagnetic state at a critical temperature. For a 47% Fe–Rh alloy, the critical temperature is above room temperature. The neutron diffraction diagram at room temperature shows three categories of rays–intense rays characteristic of body-centered lattices, superstructure rays characteristics of the order of Fe and Rh atoms, and rays of magnetic origin. When the sample is heated to 100°C, the disappearance of "antiferromagnetic" rays, slip of the majority of rays toward small angles, a very considerable increase of the relative intensity of (100) and (111) rays, and a smaller increase of the experimental intensities I (110)/I (100) are observed. The values of the localized moments were determined to be $\mu_{Rh} = 0.8 \pm 0.25\ \mu_B$ and $\mu_{Fe} = 2.84 \pm 0.25\ \mu_B$. (J.S.R.)

20467 EXAMINATION OF THE CRYSTAL STRUCTURE OF ALPHA-PLUTONIUM AT LOW TEMPERATURE. R. Lallement (Centre d'Études Nucléaires, Paris). Cryogenics, 3: 45-6(Mar. 1963).

The crystal structure of alpha-plutonium was investigated in the region of 35°K. There was no modification of crystal symmetry. Measurements indicate that alpha-plutonium has a negative expansion coefficient between 10 and 40°K. (C.E.S.)

20468 CRYSTAL STRUCTURE OF TERNARY COMPOUNDS $TiCo_2Al$, $MgNi_2In$, $TiNi_2In$ AND $TiCu_2In$. V. Ya. Markiv and M. Yu. Teslyuk (L'vov State Univ., USSR). Dopovidi Akad. Nauk Ukr. RSR, No. 12, 1607-9(1962). (In Ukrainian)

In the systems Ti–Co–Al, Mg–Ni–In, Ti–Ni–In and Ti–Cu–In the compounds $TiCo_2Al$ (a = 5.847 ± 0.004 Å), $MgNi_2In$ (a = 6.167 ± 0.004 Å), $TiNi_2In$ (a = 6.099 ± 0.004 Å), and $TiCu_2In$ (a = 6.222 ± 0.004 Å) were found, having a structure of the $MnCu_2Al$ type (space group $Fm3m-O_h^5$). In the system Ti–Fe–Al, Ti–Cu–Al, V–Fe(Co, Ni, Cu)–In, Mg–Cu–In and V–Cu–In similar compounds do not exist. (auth)

20469 CRYSTAL STRUCTURES OF MAGNESIUM-RICH COMPOUNDS IN THE SYSTEMS Er–Mg, Dy–Mg AND Y–Mg. P. I. Kripyakevich and V. I. Evdokimenko (L'vov State Univ., USSR). Dopovidi Akad. Nauk Ukr. RSR, No. 12, 1610-12(1962). (In Ukrainian)

New compounds with the structure of the Ti_5Re_{24} type (α-Mn superlattice) were found: Er_5Mg_{24} (a = 11.23 Å), Dy_5Mg_{24} (a = 11.24 Å), and Y_5Mg_{24} (a = 11.25 Å). (auth)

20470 CRYSTAL STRUCTURES OF THE COMPOUNDS $ErAl_2$ AND $ErAl_3$. P. I. Krip'yakevich and I. I. Zalutskii (L'vov State Univ., USSR). Dopovidi Akad. Nauk Ukr. RSR, No. 1, 61-4(1963). (In Ukrainian)

An x-ray investigation showed that two compounds exist in the aluminum-rich part of the system Er–Al: $ErAl_2$ ($MgCu_2$ type, a = 7.780 ± 0.002 Å) and $ErAl_3$ ($AuCu_3$ type, a = 4.214 – 4.216 ± 0.002 Å). $ErAl_3$ is in equilibrium with Al and $ErAl_2$. (auth)

20471 SOLUBILITY AND FORMATION OF NIOBIUM CARBIDE IN LOW CARBON MANGANESE STEEL. V. R. Golik, V. A. Dubov, N. I. Sandler, and V. M. Yunash (Ukrainian Metallurgical Research Inst., USSR). Fiz. Metal. i Metalloved., 14: 555-8(Oct. 1962). (In Russian)

Using electronographic, magnetic, and electric methods and hardness measurements, a study was made of the temperature range and kinetics of NbC solubility in low-carbon manganese steel. (R.V.J.)

20472 β PHASE TRANSFORMATION IN THE BERYLLIUM–COPPER SYSTEM. M. I. Zakharova and E. M. Amosov (Moscow State Univ.). Fiz. Met. i Metalloved., 14: 559-63(Oct. 1962). (In Russian)

X-ray studies of poly- and monocrystalline Cu alloys with 9.34% Be showed that the high-temperature β phase transforms, after tempering, into an ordered γ phase. Furthermore, for water-quenched monocrystalline γ phase there are slip locations on the (110) and (112) planes. There are randomly occurring masses of atoms which transform during annealing into α-phase crystals, oriented with respect to the principal structure. (tr-auth)

20473 STRUCTURE AND PROPERTIES OF In_2Bi IN LIQUID STATE. Ya. I. Dutchak, N. M. Klym, and A. G. Mykolaichuk (L'vov State Univ., USSR). Fiz. Metal. i Metalloved., 14: 787-9(Nov. 1962). (In Russian)

An x-ray study and electric conductivity and viscosity measurements were made of In_2Bi at various temperatures. The results showed that at the melting point the In and Bi atoms in In_2Bi are distributed the same as in the solid state. (R.V.J.)

20474 X-RAY STUDY OF SOLUBILITY OF IMPURITIES IN BERYLLIUM. V. M. Amonenko, V. E. Ivanov, G. F. Tikhinskii, and V. A. Finkel (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Fiz. Metal. i Metalloved., 14: 852-6(Dec. 1962). (In Russian)

The solubility of Ti, Zr, Y, and Ni in Be was studied by x-ray structural analysis of tempered samples. It was found that at room temperature only Ni has an appreciable solubility in Be. For a range of values of crystalline lattice parameters of Be saturated with gases by high-temperature exposure to air, and Be highly purified by distillation in vacuum, the saturation solubility of N and O was 2 to 3% at 900°C. Solid solution gases are not fixed in Be tempered at room temperature. It is indicated that Ni lowers the solubility of O and N in Be at high temperatures. (tr-auth)

20475 ELECTRICAL AND THERMAL RESISTIVITY OF PURE NICKEL AND OF AN IRON–NICKEL ALLOY IN MAGNETIC FIELDS AT LOW TEMPERATURES. L. Berger and D. Rivier (Université, Lausanne, Switzerland). Helv. Phys. Acta, 35: 715-32(1962). (In French)

The electrical and thermal conductivities of two samples of nickel and of one sample of 15% Fe–85% Ni alloy were measured in a magnetic field at 4.2°K and at 80.5°K. Transverse fields up to 2.2 Vs/m^2 (22 KG), and longitudinal fields up 0.18 Vs/m^2 (1.8 kG) were applied. The Wiedemann-Franz law was found to be valid in most cases in the presence of the field at 4.2°K. (auth)

20476 HIGH-TEMPERATURE PHYSICAL PROPERTIES OF CARBIDE-IODIDE THORIUM. A. F. Reid, R. E. Wilmhurst, and A. W. Wylie (Commonwealth Scientific and Industrial Research Organization, Melbourne). J. Electrochem. Soc., 110: 429-36(May 1963).

Methods were developed for measuring several of the physical properties of pure, freshly deposited carbide-iodide thorium over a range of temperatures without exposing the metal to atmospheric or other contamination. The allotropic transition of such material was located at 1325 ± 10°C, the transition from fcc thorium to bcc thorium being complete at 1335°C in less than 1 min. New values are given for the electric resistivity and total emissivity of thorium, these properties being markedly influenced by impurities in materials used by previous investigators. The morphology of the deposits was studied and related to the composition and physical properties of the metal. (auth)

20477 METALLURGICAL FACTORS INFLUENCING HOT DUCTILITY OF AUSTENITIC STEEL PIPING AT WELD HEAT-AFFECTED ZONE TEMPERATURES. T. M. Cullen (Babcock and Wilcox Co., Alliance, Ohio) and J. W. Freeman. J. Eng. Power, 85: 151-64(Apr. 1963).

The variable hot ductility of wholly austenitic Type 347 steel was found to be associated with the variable temperature of formation of a liquid phase (liquation temperature) in the microstructure of the steel. In wholly austenitic materials a low liquation temperature leads to poor hot ductility. The liquation temperature of the steel was determined to be a function of its niobium, carbon, and nitrogen contents. When ferrite is present in the steel, poor hot ductility can also occur as a result of the crack sensitivity of the two-phased structure. (auth)

20478 THE MECHANICAL PROPERTIES AND STRUCTURE OF COBALT–NICKEL–NIOBIUM ALLOYS. B. J. Piearcey, R. Jackson, and B. B. Argent (Univ. of Sheffield, Eng.). J. Inst. Metals, 91: 257-66(Apr. 1963).

The age-hardening characteristics of a series of alloys containing Co, Ni, and Nb were determined and measurements made of the tensile, impact and creep properties of the alloys. The rates of discontinuous precipitation were also recorded for three alloys, and an attempt was made to analyze the results in terms of nucleation and growth rates. Some values were determined of the mechanical properties of alloys containing Cr. (auth)

20479 THE EFFECT OF SURFACE GAS CONTAMINATION ON THE MECHANICAL PROPERTIES OF POLYCRYSTALLINE NIOBIUM. R. E. Smallman, J. Hernáez, and M. A. Adams (Univ. of Birmingham, Eng.). J. Inst. Metals, 91: 279-82(Apr. 1963).

Tensile tests on specimens prepared from an ingot of electron-bombardment-melted Nb showed that polycrystalline Nb became embrittled as the result of heating for short times at low temperatures ($\frac{1}{2}$ hr at 350°C) in air, oxygen, or nitrogen. Such a treatment gave rise to an impregnation of the surface layers of the bulk material with oxygen and/or nitrogen, which produced an embrit-

tling effect owing to the fact that these layers cracked at a low stress during mechanical testing. It was concluded that the surface cracks are the eventual direct cause of embrittlement, acting as sharp notches, which introduce triaxial stress-system effects into the specimens. (auth)

20480 HOT-HARDNESS OF DISPERSION-HARDENED MOLYBDENUM–TITANIUM AND MOLYBDENUM–ZIRCONIUM ALLOYS. A. K. Mukherjee and J. W. Martin (Oxford Univ.). J. Inst. Metals, 91: 283-4(Apr. 1963).

Investigations were made on the hardness of similar dispersion-hardened Mo–Ti and Mo–Zr alloys between room temperature and 840°C, and the values obtained were compared with those for the corresponding solid-solution alloys. There was a rapid fall in hardness values between room temperature and ~150°C, but beyond 150°C up to the maximum investigated (840°C) the relation between hot-hardness and temperature was almost linear. The results suggest that dilute Mo alloys, fabricated in the condition of solid solutions, may subsequently be usefully hardened by a nitriding heat-treatment. (P.C.H.)

20481 THE DEVELOPMENT AND PROPERTIES OF BERYLLIUM–CALCIUM ALLOYS FOR USE IN HIGH TEMPERATURE, HIGH PRESSURE CARBON DIOXIDE. T. Raine and J. A. Robinson (Associated Electrical Industries Ltd., Manchester, Eng.). J. Nucl. Mater., 7: 263-78(Dec. 1962). (In English)

The development of Be-Ca alloys for use in CO_2 at high temperatures and high gas pressures is described. Alloys were developed containing Ca in amounts greater than 0.08 wt %, that show outstanding resistance to corrosion at temperatures up to 700°C in both wet and dry CO_2 at a pressure of 21.5 atm. The corrosion resistance of the alloys decreases with a decrease in the CO_2 pressure and increases with an increase in the amount of Ca added. Variations in the H_2O content of the CO_2 from 30 ppm by weight to 300 ppm by weight have no effect on the corrosion behavior of the alloys, while an increase in the corrosion test temperature from 600 to 700°C has a negligible effect on the corrosion rate after the initial 1500 hr exposure. Indications that a satisfactory corrosion behavior could be obtained from the Be-Ca alloys at temperatures in excess of 700°C are discussed and tentative suggestions are made to explain the mechanism of corrosion of the alloys in CO_2. It is evident from the results of mechanical tests that the addition of Ca to Be in amounts up to 0.72 wt %, and probably higher, has a negligible effect on the high-temperature ductility. Heat treatment effects shown by the Be–Ca alloys are thought to be caused by an overaging reaction involving the precipitation of impurities, notably Fe present in the base Be. (P.C.H.)

20482 ELECTRON MICROSCOPE STUDIES OF DISLOCATIONS IN DEFORMED ZIRCONIUM. J. E. Bailey (Berkeley Nuclear Labs., Gloucestershire, Eng.). J. Nucl. Mater., 7: 300-10(Dec. 1962). (In English)

Dislocation arrangements observed by transmission electron microscopy in deformed Zr were found to depend upon the O and N content of the metal. In Zr containing ~0.03 wt % of O and N, tangles of dislocations, dislocation dipoles and loops were observed. In Zr containing ~0.1 wt % of O and N, the dislocations were comparatively straight and appeared more restricted to $\{10\bar{1}0\}$ planes. It is proposed that the observations may be accounted for if the stress for dislocation glide on $\{10\bar{1}0\}$ planes increases less rapidly than that for glide on the basal plane with increasing O and N content. Studies of the dislocation movement and traces observed during electron beam heating and heating stage experiments at temperatures above 400°C show that dislocation climb is an important process, and the observations suggest that self diffusion occurs in Zr at temperatures corresponding to $\sim T_m/2$ where T_m is the melting point of Zr. (auth)

20483 ELECTRICAL CONDUCTIVITY OF GRAPHITE. Ko Sugihara and Hisanao Sato (Matsushita Electric Ind. Co., Ltd., Osaka). J. Phys. Soc. Japan, 18: 332-41(Mar. 1963). (In English)

Theoretical calculations are given for the electric conductivity of graphite in the hexagonal layer planes. The resistivity increases with temperatures as $T^{1.2}$ between 25 and 77°K. In the long wave-length limit, the lattice vibrations of graphite are approximately grouped into two modes, polarization being in the layer plane in mode 1, and parallel to the c-axis in mode 2. Contributions to the relaxation process due to the scattering of carriers by the two modes are comparable in order of magnitudes. The ratio of the electron-phonon coupling constants that gives the best agreement to the temperature dependence of the observed conductivity was found to be $C_1 : C_2 = 6 : 1$, where C_1 denotes the coupling constant between carriers and the i-th mode phonons. The Hall coefficient is strongly field-dependent and the present theory could not explain the positive sign of the Hall coefficient in the low field limit. Thus in discussing the Hall coefficient a more refined theory seems to be necessary. (auth)

20484 MICROSCOPIC EXAMINATION OF $SrTiO_3$ AT LOW TEMPERATURES. Etsuro Sawaguchi, Atsushi Kikuchi, and Yoichi Kodera (Sony Corp., Yokohama, Japan). J. Phys. Soc. Japan, 18: 459-60(Mar. 1963). (In English)

Thin sections of $SrTiO_3$ were examined with a polarizing microscope in order to investigate the cubic-tetragonal phase transition and to find ferroelectric domains. When the specimens were cooled in a low-temperature microscope stage, a gradual change of the birefringence began near 100°K, with the (100) directions as the extinction directions. At the same time, a twin structure appeared with the twin boundaries running parallel to (110). Although the specimen revealed a ferroelectric hysteresis loop below 50°K, no appreciable change of the twin configuration nor any evidence of growth of ferroelectric domains was observed between 80 and 4.2°K. At 4.2°K, a large electro-optic effect, mainly due to Kerr effect, was observed. (C.E.S.)

20485 EFFECTS OF TEMPERATURE AND VELOCITY ON THE DEFORMATION PROPERTIES OF PURE TITANIUM AND THE TITANIUM ALLOY TiAl6V4. K. Wellinger and H.-J. Wittwer (Staatlichen Materialprüfungsanstalt, Stuttgart). Metall, 17: 97-107(Feb. 1963). (In German)

The strength and deformation values of Ti and Ti–Al–V alloy were determined by static tensile tests from –193 to 600°C. Between 250 and 400°C a region with decreasing deformability was observed. In this temperature range, a preliminary cold deformation decreased rupture constriction and rupture elongation very considerably. This behavior was detected both in the alloy and in the pure Ti. For low temperatures the effect of velocity on the deformation behavior of the alloy in different structure states was investigated. It was shown that the rupture constriction depended on the grain size. The rupture elongation was independent of the structure. The deformation behavior was not changed when the impact velocity was increased from 25 to 58 m/sec. The notch impact strength–temperature curve showed discontinuities at 40 and 260°C. Metallographic studies of the rupture structure showed

that the alloy at low temperatures inclined to the formation of cavities within the constriction zone. Temperature increase caused increased formation of cavities. The phenomenon was also observed in pure titanium. (tr-auth)

20486 ALLOYS OF RUTHENIUM WITH BORON, BERYLLIUM, AND ALUMINUM. W. Obrowski (DEGUSSA, Hanau, Ger.). Metall, 17: 108-12(Feb. 1963). (In German)

The structure of two-component systems of Ru with B, Be, and Al was defined by microscopic and x-ray studies and by thermal analysis in the ground state. Many crystalline types were found and their structure was determined. (tr-auth)

20487 X-RAY LINE SHIFTS IN DEFORMED URANIUM. B. D. Sharma, R. C. Bharadwaj, and K. Tangri (Atomic Energy Establishment, Trombay, India). Phil. Mag. (8), 8: 1-6(Jan. 1963).

The line shifts for (111), (112), (113), and (114) Bragg reflections were investigated in the case of uranium deformed by cold rolling. The Bragg maxima for different lines are found to shift toward either lower or higher values. It is shown from experiments on cold-rolled specimens subjected to etching that these peak shifts are not due to intergranular stresses. In view of low deformation stacking-fault probability the observed peak shifts are attributed to changes in d-spacing values due to change in lattice parameters of the cold-rolled uranium. The probability of point defects (lattice vacancies) aggregates introduced during cold-work, causing a relaxation of the lattice, is also discussed. (auth)

20488 BONDING IN THE REFRACTORY HARD-METALS. E. Dempsey (Union Carbide Research Inst., Tarrytown, N. Y.). Phil. Mag. (8), 8: 285-99(Feb. 1963).

Empirical justification is given for the assumption of a metallic-type band model for the so-called refractory hard metals on the basis that p-electrons from the nonmetal atoms (B, C, N) find themselves in the transition metal d-band on formation of the hard metals. The evidence seems to indicate that this band structure should be very similar to a standard band structure applicable to all of the transition metals. Inferences are drawn as to the general form of the d-band for the transition/hard-metal series. (auth)

20489 LOW-TEMPERATURE RESISTIVITY BEHAVIOUR OF MOLYBDENUM–IRON, NIOBIUM–IRON AND PALLADIUM–IRON ALLOYS. B. R. Coles (Univ. of California, La Jolla). Phil. Mag. (8), 8: 335-7(Feb. 1963).

The low-temperature resistivity of transition metals containing small amounts of iron was examined. Nb–Fe alloys show no abnormal variations of resistance with temperature above the superconducting transition temperature. The Mo–Fe alloys showed negative magnetoresistivities at and below the temperature of the maximum. Very dilute Pd–Fe (~0.1 at. % Fe) showed a decrease in resistivity below about 2°K but no sign of a minimum above it. This behavior suggests that the Fe atoms interact strongly enough with the neighboring palladium atoms to remove the special significance of the nearest-neighbor ion pairs that give rise in other systems to the minimum, so that the only resistivity anomaly is a decrease below the temperature of the ferromagnetic ordering. (L.T.W.)

20490 THE ALUMINIUM–TECHNETIUM SYSTEM. THE NEW PHASES $TcAl_{12}$, $TcAl_4$, AND Tc_2Al_3. L. M. d'Alte da Veiga and L. K. Walford (Cambridge Univ., Eng.). Phil. Mag. (8), 8: 349(Feb. 1963).

The existence of three phases in the Al–Tc system is reported. The phases are $TcAl_{12}$, $TcAl_4$, and Tc_2Al_3. The phase $TcAl_{12}$ has a b.c.c. structure with a = 7.5270 ± 0.0003 Å and is isostructural with WAl_{12}. The crystals are well-shaped icosahedra. The phase $TcAl_4$ is monoclinic with cell dimensions a = 5.1, b = 17.0, c = 5.1 Å and β = 100° ± 1°, Tc_2Al_3 is trigonal with a = 4.16, c = 5.13 Å. (L.T.W.)

20491 THE MAGNETIC MOMENT DISTRIBUTION IN SOME TRANSITION METAL ALLOYS. M. F. Collins and J. B. Forsyth (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 8: 401-10 (Mar. 1963).

Neutron-diffraction measurements were made on a series of iron–cobalt alloys using both polarized and unpolarized neutron techniques. The magnetic moment on the cobalt atom is shown to be broadly unaffected by alloying, while that on the iron atom increases to a value of about 3 μ_B as the cobalt concentration increases. Polarized neutron techniques were also applied to the iron–nickel system to remove an ambiguity in earlier results obtained with unpolarized neutrons; it is confirmed that the moment on nickel does not rise above 1 μ_B as the iron concentration is increased to 90%. (auth)

20492 ELECTRICAL PROPERTIES OF ANOMALOUSLY COMPOSED DALTONIDES. F. Hulliger and E. Mooser (Cyanamid European Research Inst., Geneva). Phys. Chem. Solids, 24: 283-95(Feb. 1963). (In English)

Criteria are given for the prediction of the character of the electrical conductivity in "anomalously composed" daltonides. To test the criteria, compounds of this type whose electrical properties are known are discussed in some detail. Moreover, the criteria are used to predict semiconductivity in a series of compounds such as, e.g., BaS_2, BaS_3, CsS_3, Hg_3P_4, KAs_2, ZnP_2, SnP_3, BaP_2, CdP_4, Na_2P_5, SiAs, GeAs, $SiAs_2$, etc., whose electrical properties have not so far been investigated. In compounds whose electrical properties are known, inversion of the arguments contained in some of the criteria permits predictions to be made of atomic coordination and structure. (auth)

20493 RELATION BETWEEN STRUCTURE ANISOTROPY AND SUPERCONDUCTING ANISOTROPY. J. J. Hauser and R. G. Treuting (Bell Telephone Labs., Inc., Murray Hill, N. J.). Phys. Chem. Solids, 24: 371-8(Mar. 1963). (In English)

Studies were made on 3Mo:2Re, 1Mo:1Re, 3Nb:1Zr, and 1Nb:1Zr alloys. Samples of the alloys were cold-rolled by amounts varying from 83.5 to 99% and the variation of the critical current as a function of applied magnetic field was measured. Besides the known anisotropy with respect to the rolling plane, a strong anisotropy with respect to the rolling direction was observed. Whenever a peak in critical current density was obtained, it was always possible to obtain a curve with a plateau in current density lying above it, thereby showing that the peak is not the anomaly but that the decrease or valley in current density preceding the peak is the principal anomaly. The current carrying capacity when measured along the rolling direction was higher with the field perpendicular rather than parallel to the current direction. The effect disappeared upon annealing the sample at high temperature, indicating that the structural effects of deformation were dominating demagnetization effects in the hard superconductors. The ratio of peak to valley was found to increase with increasing degree of cold rolling. This ratio varied in the different materials studied and seemed to be related to the degree of fiber structure as revealed by optical microscopy. A

tentative explanation in terms of the structural anisotropy present in the cold-rolled materials is proposed. (auth)

20494 ELECTRONIC STRUCTURE OF IMPURITIES IN NICKEL. APPLICATION OF MAGNETIC DIFFUSION OF NEUTRONS BY DISORDERED NICKEL ALLOYS. F. Gautier (Faculté des Sciences, Orsay, France). Phys. Chem. Solids, 24: 387-403(Mar. 1963). (In French)

The asymptotic form of the change $\Delta\rho(r)$ in electronic density produced in the d band of Ni by an impurity atom was computed. The structure assumed for the d bands of pure Ni was deduced from tight binding computations by a development in wave vector near to the top of the bands. $\Delta\rho(r)$ was found to be highly anisotropic; it was localized on the (100), (010), (001) atomic planes, which contain the impurity atom, and oscillated with increasing distance r, with an amplitude decreasing as r^{-2}. In ferromagnetic Ni, the change in electronic density produced a long range magnetic moment of sign alternating with increasing distance. This effect should produce a singularity in the magnetic form factor for neutron diffusion by disordered Ni base alloys. The singularity actually observed in Ni–Fe alloys might be due in part to this effect. (auth)

20495 SPIN ORDERING IN THE SUPERCONDUCTING STATE. S. H. Liu (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Chem. Solids, 24: 475-7 (Mar. 1963). (In English)

It is argued that the spin ordering in the so-called ferromagnetic superconductors is essentially the same as that in normal dilute magnetic alloys such as Mn in Cu. The range of ordering of the localized spins is much smaller than the coherence length. (auth)

20496 ELECTRONIC AND NUCLEAR POLARIZATION IN VANADIUM BY SLOW NEUTRON SCATTERING. C. G. Shull and R. P. Ferrier (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 295-7(Apr. 1, 1963).

The magnetization induced in a single crystal of pure vanadium when a magnetic field is applied was studied by means of polarized neutron scattering to identify the particular electron group that is polarized. Vanadium exhibits a weak paramagnetic susceptibility that is essentially temperature independent, and, in assessing the temperature independence of the electronic polarization, additional scattering effects associated with nuclear polarization were encountered at temperatures below 15°K. (C.E.S.)

20497 THE RELATIONSHIP BETWEEN THE UNIT CELL VOLUMES OF BERYLLIDES AND THE ATOMIC VOLUMES OF THE COMPONENTS. N. N. Matyushenko. Soviet Phys.-Cryst. (English Transl.), 7: 570-2(Mar.-Apr. 1963).

From an analysis of literature data on the structure of beryllides, regularities are established in the relationship between the cell volume of the compounds ABe, ABe_2, ABe_5, $ABe_{5.5}$, ABe_{12}, ABe_{22} and the atomic volumes of the pure components. (auth)

20498 X-RAY STUDY OF THE STRUCTURE OF YBi AND YSb. N. N. Zhuravlev and E. M. Smirnova (Moscow State Univ.). Soviet Phys.-Cryst. (English Transl.), 7: 636-7(Mar.-Apr. 1963).

Alloys corresponding to the compositions YBi and YSb were prepared and found to contain 1 to 10% eutectic. YBi is unstable in air, decomposing like ScBi but more slowly. YSb is stable in air. Both YBi and YSb crystallize in polyhedra and have the NaCl structure type, with a = 6.233 ± 0.003 for YBi and 6.155 ± 0.003 for YSb. It is concluded that the bonds are ionic. (D.L.C.)

20499 NEUTRON-DIFFRACTION STUDY OF THE TEMPERATURE DEPENDENCE OF THE ATOMIC ORDER IN AN FeCo ALLOY. V. I. Goman'kov, D. F. Litvin, A. A. Loshmanov, B. G. Lyashchenko, and I. M. Puzei (Inst. of Precision Alloys, Academy of Sciences, USSR and Bardin Central Scientific Research Inst. of Ferrous Metallurgy, Academy of Sciences, USSR). Soviet Phys.-Cryst. (English Transl.), 7: 637-9(Mar.-Apr. 1963).

In order to investigate the order-disorder phase transition in FeCo alloys, a neutron-diffraction study was made on a FeCo alloy of equi-atomic composition. A plot of the distant-order parameter shows no jump at $T/T_c = 1$, indicating that the transition is second order. The kink in the plot at 500°C is discussed in relation to the anomalous physical properties of FeCo in this temperature range. (D.L.C.)

20500 THE SOLIDIFICATION OF DILUTE BINARY ALLOYS. F. Weinberg (Dept. of Mines and Technical Surveys, Ottawa) and E. H. McLaren. Trans. AIME, 227: 112-24(Feb. 1963).

Dilute binary alloys were solidified under controlled thermal conditions, and solute distributions, temperatures during freezing and melting, and the position and morphology of the solid-liquid interfaces were examined. Binary Zn, Sn, and Pb based alloys were investigated with solute additions of Ag^{110}, Au^{198}, Sb^{124}, Tl^{204}, Sn^{113}, and Zn^{65}. Approximately 150 cc of metal was used in each ingot. Appreciable solute segregation occurred in most of the ingots, depending on the solute concentrations, distribution coefficients, and freezing conditions of the alloys. Measurements were made of the general solute distribution by sectioning layers of material from the ingot circumference and counting the activity of each layer. Local segregation was detected by autoradiographic techniques. Freezing and melting curves for the same alloys were obtained by precision resistance thermometry. The curves are related to the corresponding measured solute distribution curves and those calculated from theoretical expressions. The position and morphology of solid-liquid interfaces during freezing were determined by both decanting and quenching techniques. The results indicate the manner in which freezing and remelting occurred under the conditions investigated. (auth)

20501 EFFECT OF O_2 AND H_2 ON THE MECHANICAL PROPERTIES OF TANTALUM AND COLUMBIUM AT LOW TEMPERATURES. A. G. Imgram, E. S. Bartlett, and H. R. Ogden (Battelle Memorial Inst., Columbus, Ohio). Trans. AIME, 227: 131-6(Feb. 1963).

Notched and unnotched tensile specimens of wrought and recrystallized, oxygenated and hydrogenated Ta and Nb were tested over a range of temperatures selected to encompass the ductile-to-brittle transition. Increasing the oxygen content of Ta and Nb increased their strength, and raised their ductility transition temperature, but did not cause a marked deterioration of notch properties below that of commercially pure material. The adverse effects of oxygen were more pronounced for recrystallized structures than for wrought material. The effects of hydrogen were complicated by strain aging or slow strain rate hydrogen embrittlement at −105°F. However, in general, hydrogen had only a minor effect on strength, but markedly increased the effective transition temperature and caused a deterioration of notch properties. (auth)

20502 STANDARD HEAT OF FORMATION OF HIGHER NIOBIUM AND TANTALUM CARBIDES. A. N. Kornilov, V. Ya. Leonidov, and S. M. Skuratov. Vestn. Mosk. Univ., Ser. II, Khim., No. 6, 48-50(Nov.-Dec. 1962). (In Russian)

The standard heat of combustion for $(\Delta H^0_{298})NbC_{0.913}$ and $TaC_{0.982}$ was found to be -281.6 ± 0.5 and -303.3 ± 0.9 kcal/mole, respectively. These data and the values $\Delta H^0_{form}\ Nb_2O_5 = -453.5 \pm 0.4$ kcal/mole, $\Delta H^0_{form}\ Ta_2O_5 = -489.3 \pm 0.4$ kcal/mole, and $\Delta H^0_{form}CO_2(g) = -94.0518 \pm 0.0108$ kcal/mole were used for determining the heat of formation of $NbC_{0.913}$ and $TaC_{0.982}$. The standard heat of formation ΔH^0_{form} (from crystalline Nb, Ta, and C) was found to be: -31.0 ± 0.6, -34.0 ± 0.6, -33.7 ± 1.0, -34.3 ± 1.0 kcal/mole for $NbC_{0.913}$, $NbC_{1.000}$, $TaC_{0.982}$, and $TaC_{1.000}$, respectively. (R.V.J.)

20503 INFLUENCE OF LATTICE DEFECTS AND CATALYSTS ON THE SURFACE REACTIONS OF GRAPHITE SINGLE CRYSTALS. Gerhart R. Hennig (Argonne National Lab., Ill.). Z. Elektrochem., 66: 629-35(1962). (TID-16247). (In German)

The reaction of graphite and oxygen is accelerated by several metals. If one uses metal particles of colloidal size and graphite in the form of cleaved single crystals one can show by electron microscopy that lattice defects in the graphite are able to affect the reaction. Crystals which are free of defects are catalyzed by metal colloids only when these particles come in contact with lattice steps or edge atoms, i.e., with terminations of lattice planes. This type of catalysis accelerates the oxidative attack only in the directions which are parallel to the layer planes. Catalytic effects are confined to the interface between particle and graphite. With the exception of vanadium, the particles do not disintegrate or disperse. Lattice defects in the graphite crystal alter the catalytic reaction by facilitating the penetration through graphite layer planes and the formation of pits. This pitting can be induced by one defect in about 10^7 carbon atoms. In crystals irradiated with neutrons or electrons, the pit formation is very probably due to vacancies. Quenching of graphite does not introduce enough defects to promote this pit formation. Boron, diffused into the graphite lattice above 2000°C, causes pitting at concentrations of less than 5×10^{-7} per atom. Pitting was found to be a much more sensitive method of detecting lattice defects than the measurement of reaction rates. (auth)

20504 MEASUREMENTS ON WIRES OF THE HARD SUPERALLOYS OF THE SYSTEM NIOBIUM–ZIRCONIUM. I. Dietrich (Siemens & Halske A. G., Munich), H. Pfisterer, H. Richter, R. Weyl, and U. Zwicker. Z. Naturforsch., 18a: 93-4(Jan. 1963). (In German)

The influence of annealing temperature and time on the critical data for wires from Nb-Zr superalloys was investigated and compared with changes in structure and phases. Results are presented in graphs. At 800°C annealed wires, on account of a finely divided lamellar structure, had high critical values. (M.C.G.)

20505 MÖSSBAUER EFFECT IN $FeSn_2$ COMPOUND. V. I. Nikolaev, Yu. I. Shcherbina, and A. I. Karchevskii. Zh. Eksperim. i Teor. Fiz., 44: 775-7(Feb. 1963). (In Russian)

Resonance absorption of 14.4 and 23.8 kev γ rays in $FeSn_2$ compounds was measured above and below the magnetic transformation temperature. Co^{57} ($T_{\frac{1}{2}} = 270$ days) diffused into 1 × 18H9T stainless steel at 900°C was used as the 14.4 kev γ source, and Sn^{119m} ($T_{\frac{1}{2}} = 250$ days) as a tin dioxide coating on organic glass was used as the 23.8 kev γ source. Preliminary data on resonance absorption by Fe^{57} and Sn^{119} are analyzed. (R.V.J.)

20506 TEMPERATURE DEPENDENCE OF THE ELECTRIC CONDUCTIVITY AND HALL EFFECT OF DYSPROSIUM AND ERBIUM. N. V. Volkenshtein and G. V. Fedorov (Inst. of Metal Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 825-31(Mar. 1963). (In Russian)

The specific electric resistance and Hall emf in Dy and Er are measured in the temperature range from 4.2 to 350°K. The transition from paramagnetic to antiferromagnetic state can easily be discerned on the ρ(T) curves for Dy and Er. An investigation of the specific Hall emf for Dy revealed that extremal values of the effect correspond to transitions from a paramagnetic to antiferromagnetic state and from an antiferromagnetic to ferromagnetic state. Only a maximal specific Hall emf is observed in Er on transition from the antiferromagnetic to the ferromagnetic state. The Dy Hall effect in the ferromagnetic and antiferromagnetic region exhibits hysteresis and changes its sign from negative to positive at temperatures between 100 and 150°K. The sign of the Hall effect in Er is negative throughout the whole investigated temperature range and no hysteresis is observed. (auth)

20507 INFRARED SPECTRA OF RARE EARTH FLUORIDES. L. R. Batsanova, G. N. Grigor'eva, and S. S. Batsanov (Inst. of Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 4: 37-42(Jan.-Feb. 1963). (In Russian)

Rare earth fluorides were prepared by thermal decomposition of binary ammonium salts at 600° and heated in a vacuum up to 1300°. The low-temperature specimens are isotropic or pseudoisotropic; the high-temperature ones are anisotropic. The infrared spectra of these fluorides were studied at 2 to 25μ. In the case of fluoride hydrates exhibiting water absorption bands, there is a shifting and widening because of hydrogen bonds, and there is also an intensification in the 400 to 500 cm^{-1} region. The latter band is also present for dry fluorides and is attributed to M-F valence bond vibration. Thermal treatment does not shift the bands but lowers their intensity, which explains the decrease in the number of structural defects with annealing. (tr-auth)

20508 DIAGRAMMY SOSTOYANIYA METALLICHESKIKH SISTEM, OPUBLIKOVANNYE V 1959 GODU. VYPUCK V. (Constitution Diagrams of Metal Systems, Published in 1959. Volume 5). Z. M. Rogachevskaya. Moscow, [Publishing House of All-Union Scientific and Technical Information], 1962. 212p.

Descriptions are given of constitution diagrams, compiled from native and foreign literature, published in 1959. The reference sources are included. (R.V.J.)

Radiation Effects

Refer also to abstracts 21230 and 21346.

20509 (BNL-6912) THE USE OF COLOR CENTERS FOR THE DETECTION AND MEASUREMENT OF RADIATION INDUCED DEFECTS. Paul W. Levy (Brookhaven National Lab., Upton, N. Y.). [1963]. Contract [AT(30-2)-Gen-16]. 31p.

The use of color centers showed that the number of defects produced in NaCl by fast reactor neutrons is consistent with existing theories on radiation damage. Color centers were also used to study the growth and annealing of defects formed in Al_2O_3 and fused silica by reactor irradiations. Overall, as the annealing temperature was raised for Al_2O_3, the number of reactor-induced defects decreased and at 700 and 730°C they disappeared entirely. Reactor-irradiated samples, which were fully annealed,

did not color any more than virgin ones even with gamma ray doses of 10^9 r. Defects detected by color centers in fused silica were not removed until the samples were heated to 700°C or slightly higher. The techniques used to determine defects are described. (P.C.H.)

20510 (BSC-37051) STUDY TO DETERMINE EFFECTS OF FISSION PRODUCT GAMMA RADIATION ON ELECTRONIC PARTS AND EQUIPMENT. Progress Report No. 4, December 1, 1962–February 28, 1963. R. M. Magee and D. A. Courtois (Bendix Corp. Bendix Systems Div., Ann Arbor, Mich.). Mar. 1963. Contract NObsr-87267. 55p.

The effects of gamma radiation on semiconductor digital circuit cards from the Naval Tactical Data System Shipboard Computer and associated equipment were investigated. During this reporting period five types of circuit cards were tested in a gamma ray environment up to 3×10^5 r/hr, and up to total exposures of 1.5×10^4 r. A total of twelve circuit card types were tested in this radiation environment during the contract period. No significant radiation effects were observed on the performance of any of these circuit cards. Schematics of the five cards and of the instrumentation for the tests are included. The schematics of previously tested circuits and the characteristics of the diodes and transistors used in the twelve circuits are also given. (auth)

20511 (GACD-3223) RADIATION EFFECTS ON SILICON SOLAR CELLS. Second Quarterly Progress Report, March 1, 1962 through May 31, 1962. V. A. J. van Lint and D. K. Nichols (General Atomic Div., General Dynamics Corp., San Diego, Calif.). June 14, 1962. Contract NAS7-91. 42p.

Results of galvanomagnetic measurements on floating-zone-refined Si irradiated at 78°K and pulled n-type Si of various resistivities irradiated at 300°K are reported. Other work is reported on measurement of Si excess carrier lifetimes as function of irradiation and temperature, analysis of carrier removal rates, recombination of excess carriers, and calculation of predicted temperature dependence of carrier density, mobility, and excess carrier lifetime from a Si defects model. (J.R.D.)

20512 (GEAP-3743(Pt.II)) RADIATION EFFECTS IN BORIDES. PART II. FISSION SINTERING OF BORIDE POWDERS. E. W. Hoyt and D. L. Zimmerman (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Feb. 15, 1962. Contract AT(04-3)-189. 18p.

Post-irradiation examination of the borides used showed that the samples that were irradiated as powders sintered into firmly bonded bodies. Radiation sintering occurred at temperatures hundreds of degrees below that required to produce similar interparticle bonding by the application of heat alone. The results of the post-irradiation examination of EuB_6, B_4C, YB_4, HfB_2, ZrB_2, TiB_2, VB_2, CaB_6, and SmB_6 are discussed and compared with radiation sintering in other materials. (P.C.H.)

20513 (GEAP-3771-7) HIGH PERFORMANCE UO_2 PROGRAM. Quarterly Progress Report No. 7, October–December 1962. B. Weidenbaum (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Work performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 85p. (EURAEC-578)

A composite fuel assembly containing cored-pellet fuel rods designed to operate at 0.6×10^6 to 1.2×10^5 Btu/hr-ft^2 was irradiated for approximately 20 days. A powder-filled fuel assembly experienced a rod failure while the reactor was coming to power during a startup. The EPT-COM UO_2 fuel assembly was irradiated for ~20 days with a calculated maximum heat flux of 1.15×10^6 Btu/hr-ft^2 at the start and 0.85×10^6 at the finish of the cycle in the rod with the highest heat rating. The necessity for removal of nitrogen and residual moisture from arc-fused UO_2 to be used in compacted powder fuel rods was reviewed. The effect of central melting on swelling and the thermal conductivity of UO_2 at high temperature are discussed. An increase in temperature appeared to have a larger effect on the rate of UO_2 grain growth than time-at-temperature at temperatures above 1950°C. The rapid change in grain growth above 2400°C was found again. (M.C.G.)

20514 (IDO-14598) THE EFFECT OF RADIATION AND NITRIC ACID–NITRATE SALT SOLUTION ON SOME NON-METALLIC MATERIALS. L. A. Decker (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Dec. 10, 1962. Contract AT(10-1)-205. 30p.

Several plastic materials and one ceramic alumina were tested for possible use as electrical insulators and spacers in an electrolytic dissolver for processing irradiated nuclear fuels. They were first screened for chemical resistance to the boiling dissolver product solution composed of 1 M nitric acid and 75 g/l stainless steel metal components as nitrates. Those that were resistant were then exposed simultaneously to the boiling dissolver product solution and a gamma irradiation field. Values were obtained for the impact strength, compressive strength, and electric resistivity of the more resistant materials. Those that gave the most favorable performance were: Kynar (polyvinylidene fluoride) up to 1×10^9 rep total dose, Marlex (high density polyethylene) up to 2×10^9 rep total dose, G-7 glass fabric-silicone resin laminate up to 10^{10} rep total dose, and ceramic alumina (AP 35) to greater than 10^{10} rep total dose. If a limited service life is taken into consideration in the design of the equipment, any one of the four more resistant materials should prove acceptable for use as spacers and insulators in an electrolytic dissolver vessel. (auth)

20515 (REIC-26) TRANSIENT RADIATION EFFECTS ON ELECTRONIC COMPONENTS AND SEMICONDUCTOR DEVICES. D. C. Jones, F. J. Reid, W. E. Chapin, D. J. Hamman, and E. N. Wyler (Battelle Memorial Inst. Radiation Effects Information Center, Columbus, Ohio). Apr. 19, 1963. 111p.

The effects of nuclear-weapon-burst and simulated-burst radiation on electronic components and semiconductor devices are reviewed. Only the effects that were due to gamma rays and/or neutrons of a transient radiation environment are included. (P.C.H.)

20516 (YAEC-182(Pt. II)) YANKEE IRRADIATION SUMMARY REPORT. PART II. WCAP-1 AND WCAP-2 IN-PILE IRRADIATION CAPSULE EXAMINATION. Darryl C. Bullington (Westinghouse Electric Corp. Atomic Power Dept., Pittsburgh). Jan. 1963. For Yankee Atomic Electric Co., Boston. Contract AT(30-3)-222, Subcontract No. 1. 76p.

Eighteen fuel assemblies, containing AISI 304 stainless clad UO_2 fuel rods were irradiated in the MTR and ETR. The rods operated at power levels up to 12 kw/ft and achieved exposures as high as 30,000 Mwd/10^6 gr of U without failure. Both compartmented rods with 0.5–1.5 mil cold radial gap, and rods made by stretch-forming the clad over the fuel increased in length. Fission gas release conformed to expectations with one anomaly in which high gas release and large UO_2 grain growth occurred.

The clad and braze held up well in the 110°F process water. Description of the assemblies and various data are given. Results of fission gas analyses are also listed. (auth)

20517 EFFECT OF FAST NEUTRONS ON THE THERMAL CONDUCTIVITY OF GERMANIUM. Nguyen Van Dong, Pham Ngu Tung, and Michel Vandevyver. Compt. Rend., 256: 1722-5(Feb. 18, 1963). (In French)

Germanium crystals were bombarded with fission neutrons. The thermal resistivity due to bombardment was measured between 80 and 300°K. The results obtained show that at low temperatures the phonons are dispersed principally by faults of large dimensions. At high temperatures the relatively isolated faults impose their dispersion mode. (tr-auth)

20518 NEUTRON IRRADIATION OF SEMI-TRANSPARENT FILMS WITH PHOTOELECTRIC EMISSION. Pierre Néel (Observatoire, Paris and CEN, Grenoble, France). Compt. Rend., 256: 1950-3(Feb. 25, 1963). (In French)

Fast neutron irradiation of photoelectric cells with semi-transparent films causes a heightening of the total sensitivity, which then decreases progressively with time. The form of the spectral sensitivity curve is not noticeably modified. (tr-auth)

20519 LOW TEMPERATURE RESISTIVITY OF SELF-IRRADIATED PLUTONIUM. J. A. Lee (Atomic Energy Research Establishment, Harwell, Berks, Eng.), K. Mendelssohn, and D. A. Wigley. Cryogenics, 3: 46-7(Mar. 1963).

Strongly temperature dependent resistance of alpha-plutonium becomes largely temperature independent after reaching a saturated state of self-damage at ~5°K. The new resistivity is higher than the original one at low temperatures but lower than the undamaged value at ~90°K. Annealing restores the original resistivity curve. Radiation abolishes the mechanism responsible for the strong dependence of resistivity on temperature. (C.E.S.)

20520 ELECTRON IRRADIATION AS A METHOD OF STRENGTHENING A STEEL SURFACE. G. T. Nazarenko and F. Ya. Zagavura (Inst. of Mechanical Engineering, Academy of Sciences, Ukrainian SSR). Dopovidi Akad. Nauk Ukr. RSR, No. 1, 59-61(1963). (In Ukrainian)

An attempt was made to use an electron beam for strengthening a steel surface by means of phase transformations. Under definite conditions of irradiation a martensite transformation occurred in the surface layer. The irradiated zone may in respect to etchability be regarded as a white layer similar to that obtained on grinding, friction, impact, or blasting. (auth)

20521 FAULTS CREATED IN SOLIDS BY BOMBARDMENT WITH CHARGED PARTICLES. [PART] II. André Degeilh and René Simon (CNRS, Paris). Ind. At., 7: 81-5 (1963). (In French)

After completion of the study of the mechanism of energy transfer from the incident particle to the atoms of the solid, a simplified theory of displacements is presented. Only the first part of this theory—that related to displaced atoms and the number of faults created—is presented. It will be concluded in Part III. (J.S.R.)

20522 ON THE BREAKAWAY SWELLING IN NUCLEAR FUELS. Y. Quere, F. Pham, and J. Blin (Centre d'Etudes Nucleaires, Fontenay-aux-Roses, France). J. Nucl. Energy, Pt. A & B, 17: 15-24(Jan. 1963). (In French)

The possibility of breakaway swelling in nuclear fuels being due to coalescence of fission-gas bubbles is examined. Several possible methods of calculation are given. The results most in accordance with experiment are obtained by considering the bubbles to be distributed randomly in the fuel, to grow by gas absorption proportionally to their surface area, and to merge without an increase of nucleation sites. Curves are given showing the swelling as a function of the irradiation and the distribution of the bubble diameters in the breakaway swelling zone. (auth)

20523 IRRADIATION DAMAGE TO PILE GRADE GRAPHITE AT 450°C. B. T. Kelly, D. Jones, and A. James (United Kingdom Atomic Energy Authority, Warrington, Lancs, Eng.). J. Nucl. Mater., 7: 279-91(Dec. 1962). (In English)

Results are presented on the effects of irradiation at 450°C on the physical properties of pile grade graphite, together with post-irradiation studies of thermal annealing of property changes. The results obtained are discussed in terms of current theories of the effects of irradiation on graphite. (auth)

20524 AN INVESTIGATION OF SWELLING IN AN IRRADIATED BORON-STEEL CONTROL ROD. E. Roberts (Berkeley Nuclear Labs., Gloucestershire, Eng.) and R. S. Barnes. J. Nucl. Mater., 7: 292-9(Dec. 1962). (In English)

A 4 wt % boron-steel tube irradiated for a period of 30 months (1460 MWD/ton) at 300°C in a Calder Hall reactor was subsequently heated. No metallographic change was detected until segments were heated to 800°C, when small bubbles 300 to 600 Å in dia appeared in the Fe_2B particles. After heating to 900°C the overall volume increased by ~5% when the bubbles in the Fe_2B phase had enlarged, except near the phase boundaries, and He bubbles were also observed in the Fe phase within the recoil distance (~4 μ from the phase boundary). Eventually, after annealing at 1000°C, large irregular bubbles were seen in phase boundaries and these were then the main cause of the overall volume increase; ~30% after 24 hr at 1050°C. The effects were most marked near the outer surface of the tube and became less marked towards the inside surface, but bubbles of He presumably produced by epithermal neutrons, were observed even on the innermost surface. (auth)

20525 ANNEALING OF RADIATION DAMAGE ON LIFE-TIME IN SILICON CONTAINING COPPER AND IRON. Takao Nakano and Yoshio Inuishi (Osaka Univ.). J. Phys. Soc. Japan, 18: 465-6(Mar. 1963). (In English)

The effects of Cu and Fe on the annealing of carrier lifetime in gamma-irradiated silicon is investigated to clarify the interaction of Cu and Fe with defects created by gamma rays. The lifetime was obtained by measuring the decay of photo-injected carrier by a microwave absorption method. (C.E.S.)

20526 THE ANNEALING OF THERMAL CONDUCTIVITY CHANGES IN ELECTRON-IRRADIATED GRAPHITE. P. R. Goggin and W. N. Reynolds (Atomic Energy Research Establishment, Harwell, Berks, Eng.). Phil. Mag. (8), 8: 265-72(Feb. 1963). (AERE-R-4234)

Specimens of pure pile graphite were irradiated with electrons in liquid nitrogen, and the annealing of the resultant thermal and electrical resistivity increases was studied. An anomalous increase in thermal resistivity was found between 220 and 280°K. The effect increases rapidly with the dose and is ascribed to the formation of small complexes of interstitial atoms. Comparison with other recent low-temperature work in graphite suggests a simple model of the behavior of Frenkel defects. (auth)

20527 IRRADIATION AND A NABARRO EFFECT. D. Mosedale (Dounreay Experimental Reactor Establishment, Caithness, Scotland). Phil. Mag. (8), 8: 341-3(Feb. 1963).

Nabarro (1948) derived an expression for the strain rate of a specimen in which the creep occurs by the stress-directed diffusion of point defects generated continuously by neutron irradiation. Comments are made on evaluating the strain rate under various experimental conditions. (L.T.W.)

20528 THE LOOP SIZE DISTRIBUTION IN NEUTRON IRRADIATED COPPER. R. V. Hesketh (Berkeley Nuclear Labs., Berkeley, Glos., Eng.). Phil. Mag. (8), 8: 487-91 (Mar. 1963).

Both single interstitials and single vacancies are absorbed at dislocation loops when both are mobile. The growth of existing loops during further irradiation is therefore a second-order effect, and it is shown to be small. This necessitates new assumptions to explain the loop-size distribution observed at 300°K. A model is given in which it is assumed that loop formation takes place entirely within the displacement spike. Invariance of the loop-size distribution with dose, which is observed experimentally, follows from this assumption. It is calculated that loop nucleation occurs by the collision of two or three defects within the spike. (auth)

20529 A NEW PARAMAGNETIC CENTER IN ELECTRON IRRADIATED SILICON. G. Bemski (Bell Telephone Labs., Murray Hill, N. J.), B. Szymanski, and K. Wright. Phys. Chem. Solids, 24: 1-6(Jan. 1963). (In English)

Electron irradiation of silicon produces paramagnetic centers in n-type silicon. Experiments are described in which a new paramagnetic center is observed. In contrast to the two previously studied centers, electrons of 0.5 Mev energy do not produce the new center. The dependence of the rate of formation of this center on the energy of electrons makes it plausible that it represents a divacancy or a complex of vacancies and (or) interstitials. The symmetry of the g factor supports this idea. (auth)

20530 ANNEALING OF RADIATION DAMAGE IN QUARTZ PRIMARY CRYSTALS. P. Freymuth and G. Sauerbrey (Technische Universität, Berlin). Phys. Chem. Solids, 24: 151-5(Jan. 1963). (In German)

Quartz crystal plates (AT-cut) were irradiated by x rays up to 6×10^6 rad absorbed dose and showed the frequency decrease with saturation character already known. This decrease of the resonance frequency induced by radiation damage in the crystal was annealed at temperatures in the range from 150 to 250°C. The activation energy of the traps responsible for the change of frequency can be computed from the temperature dependence of the annealing curves. The experimental values are reproduced by two forms of traps with activation energies of $E_1 = 0.3 \pm 0.1$ ev and $E_2 = 1.3 \pm 0.3$ ev. (auth)

20531 OPTICAL AND ESR SPECTRA OF IRRADIATED CaO CRYSTALS. James C. Kemp and Victor I. Neeley (Univ. of Oregon, Eugene). Phys. Chem. Solids, 24: 332-3 (Feb. 1963). (In English)

The visible and near uv absorption spectrum of single CaO crystals irradiated with 10^{19} nvt fast neutrons shows a peak at 1.90 ev and an absorption edge at 4000 A. The ESR spectrum of irradiated CaO crystals shows a single isotropic line 1 G wide at $g = 2.0001 \pm 0.0004$. The results are consistent with the 1.90-ev band being due to positive ion vacancies. (D.L.C.)

20532 INFLUENCE OF NEUTRON-IRRADIATION AT 78°K ON THE CRITICAL FIELD OF SUPERCONDUCTING LEAD. W. F. Druyvesteyn and D. J. Van Ooijen (Philips' Gloeilampenfabrieken, Eindhoven, Netherlands). Phys. Letters, 4: 170-2(Apr. 1, 1963). (In English)

Measurements on the critical field of neutron-irradiated lead are given. Lead wires, soft-annealed for 2 hours at 200°C in vacuo, were encapsulated in an evacuated silica tube and subsequently irradiated in a low flux reactor for a period of eleven days at a temperature of 78°K. The integrated flux was about 10^{18} fast neutrons cm^{-2}. Values of the residual resistivity measured before irradiation and after recovery for 20 minutes at 353°K are listed. (C.E.S.)

20533 THE X-RAY GENERATION OF POINT DEFECTS IN POTASSIUM CHLORIDE. Edward Anton Abramson. Thesis, Philadelphia, Univ. of Pennsylvania, 1962. 241p.

The rate of generation of F centers and the induced macroscopic strain rate of KCl crystals irradiated at room temperature with 46-kvp x rays were investigated as a function of the incident radiation power density. The influence of linear plastic deformation and of massive irradiation followed by careful annealing on these two rates was also studied. The F-center concentration was measured by standard optical techniques, and the radiation-induced strain was determined by using a capacitance-type, temperature-compensated dilatometer with a sensitivity of approximately 1 A. It was found that the rate of slow-stage F-center generation varied as the 1.4 power of the incident intensity, in substantial agreement with the results reported by Mitchell, Wiegand, and Smoluchowski, and that the strain rate varied linearly with the intensity. A further set of experiments in which the ratio of the slow-stage F-center generation rate to the strain rate was investigated yielded the observation that this ratio varied as the approximately 0.7 power of the intensity. These three intensity dependences are consistent within experimental error. The discrepancy between the intensity dependences of the rates of coloration and vacancy generation is explained on the basis of a significant self-bleaching of radiation-induced color centers reported by Schultz. The deformation and annealing experiments yielded the observations that, for the crystals used, deformation had a negligible effect on the coloration rate, and that annealing at 400°C of a crystal which had been massively irradiated returned the crystal to its as-received condition. It is concluded that the predominant damage mechanism is most likely one of the bulk multiple-ionization mechanisms initiated by an inner-shell ionization followed by an Auger transition. (Dissertation Abstr. XXIII, No. 8)

PHYSICS

General and Miscellaneous

Refer also to abstracts 20149 and 20166.

20534 (AD-293438) LONG LIFE CLOSED LOOP MHD RESEARCH AND DEVELOPMENT UNIT. Interim Scientific Report No. 3, September 15, 1962 to December 15, 1962. (Westinghouse Electric Corp. Research Labs., Pittsburgh). Dec. 15, 1962. Contract AF33(657)-8311. 57p.

The construction of the component parts of the magneto-hydrodynamic closed loop and its auxiliaries is discussed. Topics covered include: status of closed loop duct, status of closed loop auxiliaries, enhanced ionization utilizing chemical disequilibrium, compatibility of tantalum and cesium, and fail safe features of cesium–helium feed and bleed system. The various possible modes of failure of the overall test apparatus were analyzed and the appropriate safety provisions were included in the design. (M.C.G.)

20535 (ARL-63-29) NON-UNIFORM SCALING OF AN APPROXIMATE H_2^+ WAVE FUNCTION. William J. Meath and Joseph O. Hirschfelder (Wisconsin. Univ., Madison. Theoretical Chemistry Lab.). Nov. 1962. Contract AF33 (657)-7311. 11p.

The approximate wave function considered for the H_2^+ molecule is $\Psi = N \exp\{-s[\gamma^2(x^2 + y^2) + (z + R/2)^2]^{1/2}\} + \exp\{-s[\gamma^2(x^2 + y^2) + (z - R/2)^2]^{1/2}\}$. Energy optimization of the nonuniform scaling parameter, γ, results in the satisfaction of the "one-coordinate" virial theorem $-(\hbar^2/2m) \int \Psi(\partial^2/\partial x^2)\Psi d\tau = (1/2) \int \Psi x(\partial V/\partial x)\Psi d\tau$. Similarly the energy optimization of the uniform scaling parameter, s, results in the satisfaction of the usual virial theorem. The simultaneous application of these two types of scaling is also discussed. (auth)

20536 (ASD-TDR-62-320) STUDY OF MHD AND EHD FREE-CONVECTION ENERGY CONVERTERS. Meredith C. Gourdine (Plasmadyne Corp., Santa Ana, Calif.). Apr. 1962. Contract AF33(616)-8007. 110p. (AD-282325)

A theoretical and experimental feasibility study of single and two-phase free-convection MHD and EHD energy conversion is summarized. Single-phase operation is shown to be impractical because the maximum possible efficiency of converting heat into flow kinetic energy is very low. On the other hand, two-phase operation is far more efficient and definitely has possibilities for practical energy conversion applications. (auth)

20537 (ASD-TDR-63-175) STUDY OF ELECTRICAL AND PHYSICAL CHARACTERISTICS OF SECONDARY EMITTING SURFACES. W. T. Peria, ed. (Minnesota. Univ., Minneapolis). Jan. 23, 1963. Contract AF33(657)-8040. 126p.

Results are presented which show that it is necessary to sputter-clean titanium crystals in the study of the variation of secondary emission with the angle of incidence of the primary beam. The nature and cause of the errors introduced when titanium is not sputter-cleaned are described. The asymmetrical structure observed in the angular dependence studies is attributed to misalignment of the crystals and some experimental results are given as evidence. The energy dependence of the magnitude of the structure in the angular dependence curves for tungsten is examined and found to be basically the same as for titanium and germanium. It is also demonstrated that sputter-cleaning is not necessary for angular dependence studies in the case of tungsten. The techniques for production of unbacked gold films are outlined. Preliminary results of studies of the energy distribution of electrons transmitted through one of these films are reported. Further results of studies of MgO films formed by the oxidation of a Mg film on a metal substrate are presented and analyzed. The concentrated study of two particular MgO films formed on Mo and W substrates has led to a quite detailed picture of the trapping centers that can occur in MgO films. Preliminary results for a second set of films are also reported. A method involving use of the destructive interference of reflected light from anodized tantalum has been devised for the determination of the ion current density as a function of position, on the target face, during the sputter-cleaning operation. An optical arrangement for measuring the amount of sputtering as a function of position on a Ta_2O_5–Ta target was built, and preliminary measurements indicate the feasibility of the measuring technique. The difficulties encountered in the study of the dissociation of NaCl thin films by low energy electron bombardment are described. The migration of Na^+ ions to the film surface is believed to be the cause of the difficulties. Results of dissociating MgO thin films are presented, and the problem of adsorbed gas on the target surface is discussed. Slow electron diffraction from the (001) surface of a MgO crystal reveals two different types of surface structure. One is a fc structure with the MgO lattice constant. The other has a double spacing in those azimuths for which the sum of the indices is even. The effects of heating and sputtering on the pattern from the fc structure are described. The effect of these treatments on the secondary electron emission is also described. A qualitative explanation of the "extra" intensity maxima in slow electron diffraction patterns is presented. A new model is proposed to explain the major peaks observed in the curves of the variation of secondary emission from single crystals as a function of the angle of incidence of the primary beam. Qualitative explanations of the manner in which the magnitude and width of these peaks vary with primary energy are given in terms of the model. The reason for the differences in the characteristics of the peaks for metals and insulators is also suggested by the model. The small peaks that occur between and superimposed upon major peaks can also be explained if the new model is combined with parts of a model previously proposed. The disagreements between this model and some of the standard assumptions in secondary emission theories are briefly discussed. Using a previous calculation as a starting point, the influence of an internal electric field on the secondary emission from ionic crystals is computed. The results are in fair agreement with experiment for the case of MgO. 41 references. (auth)

20538 (BSD-TDR-63-60) MEASUREMENT OF LOW RESISTANCE AND THE AC RESISTANCE OF SUPERCONDUCTORS. Jacob L. Zar (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Jan. 1963. Contract AF 04(694)-33. (AD-299782; AMP-100)

The resistance of highly conductive materials is measured by an induction method that does not require a direct electrical connection to the test specimen. Instead, the test sample is used as a short circuited secondary winding of a transformer. The method is suited to specimens where lead correction errors would introduce difficulty, or where the temperature or field environment requires

that the sample be located at some distance from the instruments. Resistances of the test specimen from 10^{-5} to 10^{-2} ohms are suitable for this method that was applied to determining the resistance of hard superconductors at 4.2° and at frequencies of 100 to 30,000 cps. Various niobium-zirconium alloys all followed a characteristic resistivity curve with ρ proportional to $f^{0.5}$ at high frequencies and ρ proportional to $f^{1.7}$ at f < 500 c. (auth)

20539 (CEA-1798) DETERMINATION DU SPECTRE D'EMISSION X DU PLUTONIUM. (Determination of the X Emission Spectrum of Plutonium). J. L. Bobin and J. Despres (France. Commissariat l'Energie Atomique, Paris). 1962. 4p.

The wave-lengths of some L emission lines of plutonium were determined by means of Castaing's electron probe microanalyzer. The measurements are in good agreement with results obtained using fluorescence techniques. (auth)

20540 (CEA-2254) CONTRIBUTION A L'ETUDE DES CHAMPS MAGNETIQUES DANS UNE CONFIGURATION A SYMETRIE AXIALE. (Contribution to the Study of Magnetic Fields in a Configuration Having Radial Symmetry). J. Bliaux, J. P. Durand, G. Giraud-Carrier, and R. Merard (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1963. 63p.

The method for tracing on "Teledeltos" paper magnetic induction lines (by analogy with electrical equipotential lines) in order to obtain rapid and qualitative results is recalled. The values of radial and tangential components of the magnetic induction, computed from the law of Biot and Savart, are then presented. These results are presented under the form of abaci for a configuration of parallel conductors in a rotational symmetry. Each configuration is defined by the number of conductors $1 \leq N \leq 12$ and by the radius R of the circle. The domain of computation of the value of the magnetic induction at point $M(r,\Theta)$ is limited by symmetry in a sector defined by $0 \leq r \leq 2, 5$ R and $0 \leq \Theta \leq \Theta_{max}$. (auth)

20541 (CERN-62-37) INFORMAL MEETING ON TRACK DATA PROCESSING HELD AT CERN, JULY 19, 1962. M. Benot and B. Elliott, eds. (European Organization for Nuclear Research, Geneva). Dec. 28, 1962. 107p.

Nineteen papers were presented at the meeting. Separate abstracts have been prepared for 12 papers. No transcripts are included in the proceedings for the remaining papers. Four were published elsewhere, and brief summaries of the rest are presented. (M.P.G.)

20542 (CERN-62-37(p.5-9)) INFLUENCE OF IONISATION LOSS AND COULOMB SCATTERING ON THE GEOMETRICAL RECONSTRUCTION OF TRACKS IN BUBBLE CHAMBERS. R. Boeck and S. Shapira (European Organization for Nuclear Research, Geneva).

An artificial track construction (ATC) program to simulate the behavior of tracks in a bubble chamber is described. It was found that measurement errors and Coulomb scattering cause uncertainties in the curvature of the reconstructed track, which overrule the systematic deviations caused by ionization loss. For Coulomb scattering, a formula was determined to express the uncertainty of the reconstructed results. (M.P.G.)

20543 (CERN-62-37(p.11-14)) A CRITERION FOR THE [ACCURACY] OF MEASUREMENTS OF TRACKS IN HYDROGEN BUBBLE CHAMBERS, AND HOW TO MEASURE THE TRACKS IN ORDER TO MAKE IT SIGNIFICANT. E. Fett (European Organization for Nuclear Research, Geneva).

A new geometry program, THRESH, assumes that each coördinate given by the measuring device has a constant error, δ, and the error matrix is found using the method of propagation of errors. THRESH assumes that the measurements are good, and a method is suggested for testing this assumption for each measured track. An "S^2 test" is described, where S is the spread of the measured points (on the film-views) along the reprojections of the fitted helix on the film-planes. The contributions of multiple scattering, energy loss, and systematic distortion must be $<<\delta^2$ for the S^2 test to be significant. The influence of multiple scattering is shown to increase enormously with the length of the track measured, especially for "slow" tracks. It is desirable to measure shorter parts of "slow" tracks to make the S^2 test significant, to avoid a large fraction of nonconverging tracks, and to gain accuracy in the determination of some parameters. The application of the S^2 test to real tracks is discussed. (M.P.G.)

20544 (CERN-62-37(p.19-22)) MAGNETIC FIELD AND ENERGY-LOSS CORRECTIONS FOR STRONGLY CURVED TRACKS. J. Zoll.

A new solution to the problem of correcting for an inhomogeneous magnetic field and the energy loss of particles in a bubble chamber is presented. A PANG-type approach to the reconstruction of the tracks in space is used. In the first approximation, an ideal helix is fitted to a string of space points in Cartesian coordinates obtained from stereoscopic photographs of a track. The Cartesian coordinates are converted into cylindrical coordinates ($r\phi z$), and, in the second approximation, a new helix is fitted with r and z expressed as polynomials in powers of ϕ. The determination of the coefficients of ϕ is described. From the resulting expressions for r and z, momenta and angles can be obtained. (M.P.G.)

20545 (CERN-62-37(p.23-7)) PROGRAMMING AT THE RUTHERFORD LABORATORY. J. W. Burren (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England).

The summary of the original paper states that the N.I.R.N.S. programs for track data processing are divided into 3 parts: (a) an input program to give a standard output onto magnetic tape from a number of different measuring machines; (b) a geometry program using the PANG first fit and the Solmitz helix-fitting method, the output of which is used as a library tape; and (c) a hypothesis testing and statistics routine, which up-dates the library tape with fitting results and gives a printed output. (M.P.G.)

20546 (CERN-62-37(p.29-32)) PRELIMINARY RESULTS ON PATTERN RECOGNITION AT BROOKHAVEN. P. V. C. Hough (Brookhaven National Lab., Upton, N. Y.).

The use of machines to help the scanning as well as the measuring of bubble chamber photographs is discussed. A program was set up to link individual coordinates into track elements using only the criterion of "nearness". Approximately 3,500 coordinates/sec could be processed. A second type of program used tight loops to perform linking operations while processing 15,000 coordinates/sec. The economic justification for these procedures is explored. (M.P.G.)

20547 (CERN-62-37(p.33-41)) AN AUTOMATIC SCANNING SYSTEM FOR BUBBLE CHAMBERS. H. S. White (California. Univ., Berkeley. Lawrence Radiation Lab.).

A system is described which was designed to make the scanning rates for bubble-chamber photographs commensurate with the rates of automatic measuring and data analysis. Total event processing is separated into

several phases: abstraction, event recognition, measurement, and computation. The abstraction phase recognizes track elements within each view and abstracts onto magnetic tape basic information describing each track segment. In the scanning phase, track segments described on the magnetic tape abstract are compared to specified scanning criteria. In the measurement phase, events selected during the scanning phase are measured and numerically analyzed by Flying Spot Digitizer (FSD) programs. The function of the abstraction program is discussed, and the advantages of maintaining a separate abstraction phase, rather than combining it with the measurement phase, are enumerated. (M.P.G.)

20548 (CERN-62-37(p.43)) RESULTS OBTAINED WITH THE SPIRAL READER. L. W. Alvarez (California. Univ., Berkeley. Lawrence Radiation Lab.).

The Spiral Reader makes a spiral scan of particle-track photographs and records what it sees on magnetic tape. Photographs of the Spiral Reader and the data that it records are presented. The magnetic tape is then fed into a 709 or a 7090 computer, where a filtering operation takes place. Photographs of the data after filtering are also shown. (M.P.G.)

20549 (CERN-62-37(p.45-8)) ON-LINE ASPECTS OF SMP. J. N. Snyder (Illinois. Univ., Urbana).

The SMP particle-track-scanning device can be connected to a computer with a fast data channel and interruption facilities for automatic track-data processing. The operation of several SMP's with a 7090 computer is described. (M.P.G.)

20550 (CERN-62-37(p.55-7)) MULTIPLE SLIT ROTATING ANALYSER. G. Brautti (Trieste. Università).

The MSRA is a device of intermediate speed and precision, which provides a reasonably fast analysis of some types of bubble-chamber events without the need of a large computer. The vertex of an event must be centered on a rotating disc. Twelve photocells are located under a slit in the disc, and a pulse is obtained each time the shadow of a track falls on a cell. The operation of the device and two types of circuits to analyze the pulses are described. The device can process 5 events/hr (for 6-prong stars) and provides information on punched tape for 12 points on each track and each view. A later design will be able to process 30 events/hr and will provide information on the projected angle and curvature of each track. The cost of the earlier device is $3000 and of the later one, $5000. (M.P.G.)

20551 (CERN-62-37(p.59-63)) RHODA: A PROPOSED RAPID HAND-OPERATED DIGITIZING APPARATUS FOR THE MEASUREMENT OF TRACK CHAMBER PHOTOGRAPHS. O. R. Frisch ([Cambridge Univ., England. Cavendish Lab.]).

An apparatus is described, which is simple and cheap and needs no computer on line. A particle-track photograph is projected down onto a horizontal table. An operator slides a flat box along the table until the desired track falls between two lines on the box and is roughly parallel to them. The point whose coordinates are wanted should lie on the center line. A sliding piece with a scanning slit on the box is caused to slide quickly ~1 cm and back again. A photocell under the slit records the dip in brightness as the slit crosses the track image. The distance the slit has to travel to the middle of the track is converted into digital form by electronics and punched on a tape. Information on the accurate position of the box and the angle between the x-axis and the direction in which the sliding piece moved is also recorded on the tape. A total of 44 bits of information must be recorded for each measurement. The coordinates of the midpoint of the scanning slit can then be determined by a computer. (M.P.G.)

20552 (CERN-62-37(p.73-80)) "CHLOE"—A SYSTEM FOR THE AUTOMATIC HANDLING OF SPARK PICTURES. J. W. Butler (Argonne National Lab., Ill.).

The equipment consists of 2 main elements, a mass-produced general-purpose digital computer (ASI-210) and a cathode-ray-tube scanner under control of the computer. Programs corresponding to a given experiment are loaded into the main computer and the ASI-210. Every frame of the film is scanned, but only those pictures which pass through a selection program in the ASI are transmitted to the main computer for further analysis. Diagrams and pictures of the present setup are included, and a detailed description of the equipment and its operation is given. A program is now being written to attempt the processing of data from an actual spark-chamber experiment. (M.P.G.)

20553 (CERN-62-37(p.83-92)) A SCHEME FOR AUTOMATIC PROCESSING OF BUBBLE CHAMBER AND SPARK CHAMBER PHOTOGRAPHS. A. R. Edmonds.

The design of a high-speed film-measuring and data-processing system is described. The measuring device is a flying-spot scanner, which covers the particle-track photographs line by line. The photographs lie on a cylinder and are scanned by 12 spots of light emitted radially by a rotor whose axis coincides with that of the film cylinder. Measurement of distance across the film may be replaced by electronic measurement of time intervals if the rotor runs at a very constant speed. The design and associated electronics of the measuring device are described. A small, relatively inexpensive computer can be used. A few seconds of a large computer will be needed to complete the calculations. (M.P.G.)

20554 (DCAS-TDR-62-121) MATERIALS PROBLEMS OF FLIGHT VEHICLE POWER. Rex A. Barney (Aerospace Corp., El Segundo, Calif.). June 18, 1962. Contract AF04(695)-69. 40p. (AD-282348; TDR-69(2703-01)TR-1)

Information is presented on materials research in the form of a reference document. It is noted that materials problems are closely related to development of energy conversion devices and are investigated concurrently in many cases. However an effort was made to present information primarily concerned with materials rather than with auxiliary power technology. (J.R.D.)

20555 (EANDC(E)-38(L)) PROGRESS REPORT ON NUCLEAR DATA RESEARCH IN THE EURATOM COMMUNITY. J. Spaepen (European American Nuclear Data Committee). Dec. 1962. 73p.

Information on nuclear data measurements underway in the Euratom Community is presented. Reports from 17 research centers are presented (13 in English, 4 in French). (M.C.G.)

20556 (GA-2732) THE APPLICATION OF DIFFERENTIAL THERMAL CALORIMETRY TO MEASUREMENTS OF STORED-ENERGY RELEASE IN METALS. J. L. White and Karl Koyama (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Aug. 6, 1962. Contract AT (04-3)-167. 33p.

A differential calorimeter operating by the method of quantitative differential thermal analysis was developed to study stored-energy-release spectra in metals. The method involves the heating of a fully annealed reference specimen and a test specimen of approximately equal size by heat transfer from a uniformly heated calorimeter block programed to a reproducible increase in temperature with time. The initial stored-energy-release run is fol-

lowed by a base-line run under identical conditions to determine the small differences in thermal coupling of the specimens to the block. The most stable conditions of thermal coupling were obtained by the use of cells to contain the specimens and by continuous purification of the He used as a thermal-exchange gas. Calibration experiments on the heat of fusion of lead were carried out to evaluate the thermal coupling between specimens and to confirm the calorimetric technique; the correction for thermal exchange between specimens is incorporated in the computer program for data reduction. Measurements of stored-energy release in specimens deformed in compression to approximately 40% true strain were made on two lots of commercial Cu and one lot of high-purity copper. The results demonstrate the existence of an appreciable grain-size effect on the total stored energy and the stored-energy-release spectrum. The data for high-purity Cu agree well with previous work on a similar grade of Cu deformed in tension. The presence of impurities in the commercial Cu alters the total stored energy and shifts the stored-energy release to higher temperatures. (auth)

20557 (IPPJ-5) CANONICAL FORMALISM OF THE MOTION OF A CHARGED PARTICLE IN A MAGNETIC FIELD. Satio Hayakawa and Haruo Obayashi (Nagoya, Japan. Univ. Inst. of Plasma Physics). Feb. 1963. 59p.

The motion of a charged particle in a static magnetic field with axial symmetry is formulated by introducing a set of canonical variables, ambiguities in intuitive theory thereby being avoided. It is shown to be possible to choose these variables as describing three modes of motion: the gyration about a line of force, the drift along the line of force, and the azimuthal drift about the symmetry axis. The hamiltonian expressed in terms of these variables is expanded in power of a small parameter that is of the same order of magnitude as the ratios of the gyration radius to the radii of curvature of a line of force and of a magnetic equipotential line and also to the distance from the axis. The zeroth order hamiltonian thus obtained describes the motion in the first order orbit theory, whereby the magnetic moment is taken as equal to the action variable of the gyration mode at a line of force at which the kinetic angular momentum vanishes. The mirror point migration is obtained in a higher order approximation. This effect results, when applied to geomagnetically trapped particles, in the increase of the thickness of matter traversed by the particles, because of a steep altitude dependence of air density, and may be responsible for the absence of high energy protons in the outer radiation belt. Through this application the present method is shown to provide a good approximation in the case of large γ, where γ is Størmer's constant of integral proportional to the angular momentum about the symmetry axis. 28 references. (auth)

20558 (NP-12695) THE FERMI-CONTACT CONTRIBUTION TO THE PROTON-DEUTERON COUPLING CONSTANT IN HD. J. I. Musher (Harvard Univ., Cambridge, Mass.). [1962]. 6p.

A new approximate procedure for performing perturbation calculations on simple unperturbed molecular wavefunctions introducing no arbitrary parameters, enables the relatively facile calculation of some molecular properties. This procedure is used to calculate approximately the Fermi-contact contribution, J_F, to the indirect scalar coupling between the nuclear spins in HD. (auth)

20559 (NP-12696) TIME-INDEPENDENT PERTURBATION THEORY BY GAUGE TRANSFORMATIONS. Jeremy I. Musher (Harvard Univ., Cambridge, Mass.). [1962]. 24p.

A given solution ψ_0 of a one-electron Schrödinger equation for hamiltonian $\mathcal{H}_0$ is shown to be also the solution to the Schrödinger equation for a particular gauge-transformed hamiltonian when any given perturbation $\eta\mathcal{H}_1$ is added to $\mathcal{H}_0$. This transformation is obtained from solutions to inhomogeneous partial differential equations similar to those of Dalgarno and Schwartz and has the virtue of giving the energy expectation value in a particularly simple form. The corresponding many-electron gauge-transformation is also treated; and, despite the fact that the equations obtained are in general not exactly soluble, the procedure does provide a useful visualization of the electron correlation contributions to the energy. An approximation for multi-center wave functions, which amounts to choosing a different gauge for each center, is also presented; and the error introduced is discussed. 23 references. (auth)

20560 (NP-12698) THERMOELECTRIC POWER IN NONSTOICHIOMETRIC $\alpha - Nb_2O_5$. Technical Report No. 4. R. F. Janninck and D. H. Whitmore (Northwestern Univ., Evanston, Ill. Technological Inst.). Mar. 29, 1963. Contract NONR-1228(16). 16p.

Thermoelectric power measurements were made on nonstoichiometric $\alpha - Nb_2O_5$ over the temperature range 300 to 1270°K. The measurements show that, for all compositions in the single-phase, $\alpha - Nb_2O_{5-x}$ region ($0.0012 \leq x \leq 0.1545$), the majority of charge carriers are electrons. The thermoelectric power data are interpreted in terms of a simple semiconductor exhibiting conduction in a narrow d-band with the conduction electrons being assigned an effective mass equal to four times that of the rest mass. (auth)

20561 (NP-12715) MHD GENERATOR PERFORMANCE UNDER NON-UNIFORM AND TIME VARYING LOAD. Research Report 148. J. F. Louis and R. Decher (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Mar. 1963. 21p.

An MHD (magnetohydrodynamic) generator with segmented electrodes was idealized as a one-dimensional channel with infinite segmenting. Transient and steady state effects due to local non-uniformities on the remainder of the channel were investigated. (auth)

20562 (NP-12717) RESEARCH AND DEVELOPMENT ON A VORTEX MHD POWER GENERATOR. Final Report, September 21, 1960 to December 8, 1961. (TAPCO, Div. of Thompson Ramo Wooldridge Inc., Cleveland). Dec. 1961. Contract NAS5-703. 52p. (ER-4737)

An experimental and theoretical program was conducted in order to investigate the performance of a continuous-flow crossed-field MHD (magnetohydrodynamic) power generator within which the working fluid has a vortex motion. The experimental effort involved construction and operational test of small vortex and linear channel generators as well as cold-gas vortex chambers. The result of this effort plus supporting theoretical work was the definition and evaluation of the various practical problems associated with the vortex MHD generator concept. Successful generator operation in the 3000°K range for periods exceeding 30 minutes was obtained. In addition progress was made in defining acceptable geometries and techniques for attaining the required hydrodynamic flow performance. The primary emphasis of the theoretical study was concerned with improving the understanding of turbulence in two-dimensional vortices and in defining optimum methods of attaining the desired velocity profiles. During this effort a theory of turbulence in a vortex, based on the concepts of mixing length, was evolved. (auth)

20563 (NYO-10062) PROGRESS REPORT [ON NUCLEAR RESEARCH]. (Massachusetts Inst. of Tech., Cambridge. Lab. for Nuclear Science). Nov. 1, 1962. Contracts AT(30-1)-2098; AT(30-1)-905; NASw-37; and NASw-75. 89p.

Progress in research on nuclear science is reported. Studies on chemistry of fission elements, nuclear chemistry, cosmic radiation, bubble chamber, linear accelerator, high-energy accelerator physics, Rockefeller generator, ONR generator, radioactivity, cyclotron, and theoretical nuclear physics are described. (M.C.G.)

20564 (TID-18442) LOW ENERGY NUCLEAR PHYSICS. Progress Report, June 1, 1962 to May 31, 1963. R. R. Roy (Pennsylvania State Univ., University Park. Coll. of Chemistry and Physics). Mar. 1963. Contract AT(30-1)-2399. 25p.

Status of the 5.5-Mev Van de Graaff generator and the pulse height analyzer and vaccum evaporator to be used with it are reported. Research to be undertaken at the facility is also described. Total absorption coefficients for neutron-capture gamma rays of 5.4, 6.4, 7.7, and 10.8-Mev were measured for the elements Be, Al, Cu, Sn, and Pb. Angular distributions of 1.37-Mev gamma rays from the $Mg^{24}(n,n'\gamma)Mg^{24}$ reaction and of the 0.85-Mev gamma rays from $Fe^{56}(n,n'\gamma)$ reactions were measured and found to agree with Satchler's theory. Circuitry giving good discrimination against γ pulses produced in a stilbene crystal was constructed. Using previously discussed methods, the cross sections for the $Li^7(\gamma,n)Li^6$ and the $B^{10}(\gamma,n)B^9$ reactions at energies around 10 Mev were measured. Study of the Se^{81} decay scheme revealed gamma rays of 827, 647, 565, 545, 428, and 180 kev. The data also indicate Br^{81} states at 827, 647, 565, 428, and 282 kev. Investigation of the Ba^{139} decay scheme indicated gamma rays of 0.166, 1.25, and 1.41 Mev; but gave no evidence for 0.28, 0.50, 0.78, 0.95, or 1.09 Mev rays. A weak 0.84-Mev gamma ray was noted, and some interesting γ-γ and γ-x ray coincidences were observed. Evidence was also found for a 0.134-Mev transition. A crossover gamma ray of low intensity between the 1420-kev level and the In^{115} ground state was indicated for the Cd^{115} decay scheme. An unsuccessful search for an Os^{187} isomeric state was made. Gamma-gamma coincidence studies of the decay of 24-hr W^{187} were completed. Research currently in progress includes examination of double-quantum deexcitation of nuclei; of the triple cascade in Zn^{71} decay; of the (n,α) cross section in Sm^{149}, Gd^{155}, and Gd^{157}; of the neutron fission of Th^{232}; of (n,α) and (n,p) reactions initiated by reactor neutrons; and of photofission and (γ,n) reactions in Th^{232} and U^{238}. Theoretical work dealt with neutral and scalar theory with recoil, triplet production in H, the Levinson theorem in soluble models of field theory, model field theories, photoproduction of κ mesons on deuterons, retardation effects in deuteron photodisintegration, Regge trajectories for n-n scattering systems, sensitivity of nuclear matter parameters to the two-body potential, p-p scattering at 650 Mev, and the theory of (d,γ) reactions. Abstracts of 13 papers submitted for publication during 1962–1963 are included, and references to 11 other papers that appeared since the last report are given. (D.C.W.)

20565 (UCRL-10022) THE BERKELEY HIGH-ENERGY PHYSICS STUDY AT THE ERNEST O. LAWRENCE RADIATION LABORATORY, BERKELEY, CALIFORNIA, JUNE 15 THROUGH AUGUST 15, 1961. (California. Univ., Berkeley. Lawrence Radiation Lab.). Contract W-7405-eng-48. 264p.

Seminar talks and special reports presented by the Berkeley summer study group are compiled. Included in the compilation are 24 seminar talks, 10 reports, a summary of theoretical conclusions, and comments on experimental questions. Separate abstracts have been prepared for 18 seminar talks and all of the reports. Five seminar talks have been abstracted previously in NSA. (M.P.G.)

20566 (UCRL-10022(p.3-7)) REPORT ON THE CERN CONFERENCE: "THEORETICAL ASPECTS OF VERY-HIGH-ENERGY PHENOMENA." Steven Frautschi (California. Univ., Berkeley).

The purpose of the conference was to survey what is known or conjectured about the very high-energy region and to determine what questions can be asked at these very high energies. The conference included a few talks on accelerator and cosmic-ray data and many talks on theory. The theoretical talks are briefly summarized under the headings: Weak Interactions; Quantum Electrodynamics; Strong Interactions; and Exceptional Processes. Possible future machines were discussed. High-intensity colliding electron beams of 1 Bev or more were felt to be desirable. The relative advantages of colliding 25-Bev proton beams, a 300- to 500-Bev proton accelerator, and a high-intensity accelerator at 25 Bev are mentioned. (M.P.G.)

20567 (UCRL-10022(p.42-5)) NEUTRINOS AND WEAK INTERACTIONS. Normal Dombey (California Inst. of Tech., Pasadena).

A survey of existing theories which have particular reference to high-energy neutrino reactions is presented. The topics discussed include pure weak interaction (leptons), strongly interacting particles, intermediate bosons, strange particles, and total cross sections. (M.P.G.)

20568 (UCRL-10022(p.47-51)) SOME CONSIDERATIONS OF EXPERIMENTAL FACILITIES FOR A 300-Gev ACCELERATOR. Leroy T. Kerth (California. Univ., Berkeley. Lawrence Radiation Lab.).

Consideration is given to the type of experiment and experimental equipment that may be needed for a 300-Bev accelerator. To conserve accelerator operating time, a number of experimental setups should be provided for simultaneously. An achromatic set of three magnets in a long straight section of the machine is recommended to provide secondary-particle beams. An external proton beam should be extracted from the machine, and an extraction system that would provide a beam with a workable duty cycle needs to be developed. A useful feature of the machine that should be considered in its design is the possibility of reducing its energy and increasing its repetition rate. A large amount of space should be provided for the experimental areas, and heavy shielding will be required. (M.P.G.)

20569 (UCRL-10022(p.52-7)) SEPARATION OF PARTICLE BEAMS AT HIGH ENERGIES. Denis Keefe (California. Univ., Berkeley. Lawrence Radiation Lab.).

Methods of spatial separation that might be possible with a high-energy accelerator (r-f and electrostatic, interaction, degradation, and triggered) are described. All of the methods end up with low flux, ~10 to 100 particles/pulse, primarily suited to bubble chambers. Suggested methods of time separation include time of flight, gas Cherenkov counters, relativistic rise, and synchrotron radiation. Time of flight and synchrotron radiation do not appear to be feasible. Gas Cherenkov counters of the threshold type and the differential type are discussed in some detail. Tables of parameters for threshold counters selecting π-mesons only and for counters selecting π and K mesons are presented. The great advantage to the differential

counter is the saving in required length by eliminating a separate threshold counter to reject pions. (M.P.G.)

20570 (UCRL-10022(p.58-73)) RESULTS FROM COSMIC-RAY EXPERIMENTS. Donald H. Perkins (Bristol Univ., England).

Cosmic-ray flux is very low at high energies, and therefore in cosmic-ray experiments, only the major features of the interactions can be measured, not the detailed characteristics. Cosmic-ray measurements indicate that the total inelastic cross section in medium and heavy nuclei remains constant over the energy range 5 to 20,000 Bev. Determinations of the attenuation length of shower-producing radiation are interpreted to mean that, on the average, the incident nucleon re-emerges from a collision with about half of its original energy for all energies from 10^2 to 10^7 Bev. A graph of the multiplicity, n_s, of the charged secondary relativistic particles as a function of primary energy shows that n_s depends on energy. Measurements with emulsions and multiplate and magnetic cloud chambers show that pions are the most copiously produced particles in nuclear collisions. K particles plus baryons constitute ~20% of the created particles between 20 and 10^6 Bev primary energy. In the primary energy range 2000 to 10,000 Bev, K mesons are much less numerous than pions, and the ratio of pions to nucleons is ~20%. The energy distribution of pions and the angular distributions and other features of high-energy events are also discussed. The results are not dramatically different from those observed at lower energies. The Fermi-Landau statistical theory is unable to account for the low value of the elasticity coefficient in the majority of collisions. Some peculiarities observed at very high energies might be detectable at much lower energies with more refined measurements. (M.P.G.)

20571 (UCRL-10022(p.74-82)) COLLIDING-BEAM TECHNIQUES. Gerald K. O'Neill (Princeton Univ., N. J.).

The status of the Princeton-Stanford colliding-beam experiments, designed to study the elastic scattering of electrons on electrons at a total energy of 1 Bev (c.m.), is reported. CERN studies on the design of a colliding-beam device and theoretical studies at Princeton on storage-ring design are briefly summarized. The limitations and disadvantages of proton-proton colliding-beam systems include the impossibility of putting a detector at the primary production point, the low intensity and energy of secondary beams, and the comparative inconvenience of applying an analyzing magnetic field to the active region. The advantages of doing experiments by colliding beams include the achievement of higher energies, the increase by a factor of 30 to 100 in the duty cycle of storage rings over that of conventional machines, and the possibility of making mass measurements on more than one relativistic secondary from a single interaction. The high-resolution momentum-analyzing spark chamber, which is essentially a perfect match to a colliding-beam source, is described. It is recommended that synchrotrons above 25 Bev be designed so that they will be good injectors for storage rings. (M.P.G.)

20572 (UCRL-10022(p.83-8)) ROUND TABLE DISCUSSION OF THEORETICAL INTEREST IN 300-Gev PROTON ACCELERATOR. Daniele Amati (European Organization for Nuclear Research, Geneva); Kenneth M. Case (Michigan. Univ., Ann Arbor); G. F. Chew (California. Univ., Berkeley); Norman Dombey (California Inst. of Tech., Pasadena); S. G. Frautschi (California. Univ., Berkeley). S. G. Gasiorowicz (Minnesota. Univ., Minneapolis); C. J. Goebel (Wisconsin. Univ., Madison); and D. Y. Wong (California. Univ., La Jolla).

Opinions about the impact on theory of a proton accelerator of ~300 Bev are discussed. The energies are almost certainly not high enough to unify the traditional 3-way division of particle physics according to interaction strength. Three possible situations with respect to strong interactions at these energies are presented: (1) there exist undiscovered symmetries that lead to metastable strongly interacting particles; (2) there are "hidden" symmetries implying unstable particles of unpredictable masses with lifetimes of $\sim 10^{-23}$ sec; and (3) no further symmetries exist and the S-matrix theory will explain everything to be observed in the strong-interaction domain. The detection of underlying symmetries and the classification of general n-particle states are discussed. Although the principal speaker (Chew) supports the S-matrix theory, he quotes a discussion with Oppenheimer, who feels that experiments with a super-high-energy machine will promote understanding of the nuclear and subnuclear world. Some qualitative questions concerning weak interactions are asked, and the answers suggest that a 300-Bev accelerator may not be very helpful in this area. (M.P.G.)

20573 (UCRL-10022(p.89-95)) INTERACTION OF 11.3-Gev PIONS WITH PROTONS. William B. Fretter (California. Univ., Berkeley).

Nuclear interaction events satisfying the criteria for interactions of negative pions with protons were measured from photographs of events in a propane-freon chamber exposed to 11.3-Bev pion beams. Results were interpreted in terms of the one-pion exchange (OPE) model. The work is still in progress, so the results are indicative rather than definitive. Events are categorized in terms of the OPE model, and results are given in each category, looking for regularities in the distributions. The categories are indicated and labeled in diagrams, and the data for each category are presented in tables. Results indicate that ~3/4 of the pion-proton events at 11 Bev are peripheral involving a small momentum transfer to the nucleon. The average value of proton inelasticity was found to be 0.28, and of π^- inelasticity, 0.50 for all events listed. It appeared that 11 Bev/c is too low a primary momentum to separate clearly the 2 vertices in events with 3 or 4 negative particles. The method shows promise of clarifying the process of multiple production of pions. (M.P.G.)

20574 (UCRL-10022(p.96-104)) MUON BEAMS FROM A 300-Gev ACCELERATOR AND THEIR APPLICATION TO MUON-PROTON SCATTERING AND THE PROCESS $\mu + p \rightarrow \nu + N$. George F. Masek (Washington. Univ., Seattle).

The magnitude and quality of muon beams that might be expected from the proposed 300-Bev accelerator are estimated, and the application of these beams to experiments that might be of interest is discussed. It is concluded that muon beams of relatively high intensity (10^5 to 10^9 muons/Bev/10^{12} protons over an area of ~300 cm^2) and high energy (20 to 50 Bev) would be obtainable, although large distances (~2000 m for the higher energies) would be needed to allow for the pion decays. Data from the muon-beam calculations are tabulated. The use of muon beams from the 300-Bev accelerator in muon-proton elastic scattering experiments is discussed. Cross sections with momentum transfers of the order of 13 Bev/c (~3 times those obtainable with Stanford's proposed 15-Bev machine) could be measured with 5 to 10% statistical accuracy and with sufficient momentum accuracy to define elastic scattering. Accurate comparison experiments

between e – p and μ – p elastic scattering would be possible. Yields for experiments investigating the weak-interaction process $\mu + p \rightarrow N + \nu$ would be also reasonable if the proton current could be increased to 10^{13} protons/pulse. (M.P.G.)

20575 (UCRL-10022(p.105-7)) MUON BEAMS. Steven C. Frautschi (California. Univ., Berkeley).

A 300-Bev accelerator would produce beams of highly energetic pions, which would decay chiefly in the modes $\pi^{\pm} \rightarrow \mu^{\pm} + \nu$ and $\pi^0 \rightarrow 2\gamma$. Energetic muons and photons produced in this way can be used to study some questions of fundamental interest. The reaction $\mu + p \rightarrow \mu + p$ at large momentum transfers is investigated. Results could provide information on form factors $F_\mu F_p$ for momentum transfers up to ~10 Bev, and, when combined with electron-scattering results from the 15-Bev electron accelerator, F_μ/F_e could be tested up to ~5 Bev. It appears that $\mu + p \rightarrow \mu + p$ at momentum transfers of 10 Bev might provide useful information that could not be obtained from lower-energy higher-precision studies. Wide-angle pair production of electrons ($\gamma + p \rightarrow e^+ + e^- + p$) or other charged pairs could also be used to study electrodynamics at small distances. A polarized muon beam can be obtained from pion decay, but no good use has been found for it. (M.P.G.)

20576 (UCRL-10022(p.108-14)) PARTICLE SEPARATION AT HIGH ENERGIES. Sulamith Goldhaber (California. Univ., Berkeley. Lawrence Radiation Lab.).

If bubble chambers are to have an important place in future high-energy particle research, the primary particle beams must be enriched. A method for enriching an antineutron beam of 8 Bev/c utilizing characteristic differential cross sections is described. A momentum-selected negative beam passes through an absorber, in which it interacts to produce charged and neutral particles. The charged secondaries are swept out of the beam by a magnet. The neutral beam, consisting of antineutrons, neutrons, K_2^0, and γ rays from π^0 decays, is passed through a lead converter followed by a second sweeping magnet. The remaining beam consists of antineutrons, K_2^0, and some neutrons. Preliminary tests of this method proved most encouraging. Possible extensions of the method to yield a purified $\bar{p}$ beam or pure K^+ and K^- beams are described. Reasons are presented for believing that separation by strong interaction should be applicable at ultrahigh energy and may find prominent application with machines of 100 to 1000 Bev. The possible application of the relativistic rise in the energy loss to identifying particles of different masses is briefly discussed. (M.P.G.)

20577 (UCRL-10022(p.127-35)) OUTLINE OF AGS EXPERIMENTS AND 1000-Gev ACCELERATOR STUDIES. PART I. EXPERIMENTS AT THE BROOKHAVEN AGS. PART II. STUDIES FOR 1000-Gev ACCELERATOR. Luke Yuan (Brookhaven National Lab., Upton, N. Y.).

The first major experiment on the alternating-gradient synchrotron was an investigation of the composition of beams coming from an internal target and measurements of the distribution of the particles in energy and angle. The experiment and its results are described, and data are presented in graphs. Current experiments on the AGS are listed, and future experiments are mentioned. Topics to be studied in connection with a 1000-Bev accelerator are listed with the names of the people responsible for them. (M.P.G.)

20578 (UCRL-10022(p.138-41)) ON THE DETECTION OF INTERMEDIATE BOSON PAIR PRODUCTION. L. J. Koester, Jr. (Illinois. Univ., Urbana).

The difficulties entailed in identifying boson pair-production events are summarized. Some features of the kinematics of pair production that might make an experiment possible are discussed. Expressions for momentum transfer and cross section for pair production are presented, and the importance of the role of momentum transfer is emphasized. Pair production in Pb by high-energy photons with small momentum transfer is examined. Assuming a countable γ-ray beam of order 10^7 photons/sec and a 1-cm-thick Pb target, the yield of B^8 pairs in a 10% energy interval was determined to be of the order of 1/min. (M.P.G.)

20579 (UCRL-10022(p.142-3)) DIFFRACTION SCATTERING OF π^+ MESONS, K^+ MESONS, PROTONS, AND ANTIPROTONS. Leroy T. Kerth (California. Univ., Berkeley. Lawrence Radiation Lab.).

An experiment for measuring the diffraction scattering of particles at very high energies is proposed. Using 100-Bev/c particles, the experimental arrangement to produce a beam of known momentum and to select particles of a particular mass is described. Two magnets serve as spectrometers on each site of a liquid hydrogen target. Four spark chambers coupled with one of the magnets measure the momentum and direction of the particle going into the target. The 4 spark chambers and the other magnet measure the momentum and direction of the particles emerging from the target. On the basis of reasonable guesses of the total cross section for elastic scattering, a secondary beam of 10^6 particles/pulse should produce 100 scatterings/machine pulse. (M.P.G.)

20580 (UCRL-10022(p.144-50)) THE WEAK INTERACTION AT HIGH ENERGY: PROGRESS OF THE NEUTRINO EXPERIMENTS OF CERN AND POSSIBLE ADVANTAGES OF A 300-Gev MACHINE. Jack Steinberger (Columbia Univ., New York).

Questions about the weak interaction that might be answered are: (a) Are there two kinds of neutrinos? (b) Is the weak interaction carried by bosons of intermediate mass? (c) What is the form factor for the weak interaction, and what is the form at higher momentum transfers? Expected cross sections for weak interactions are of the order of 10^{-38} cm^2. Only neutrino reactions are being studied, since neutrinos can be purified from strongly interacting particles without loss of energy and with little loss of intensity. The layout of the CERN experiment now being set up is described. A pion beam brought out from an internal target in the proton synchrotron will be used. Estimates of the expected rate of interesting events are extremely low, and efforts are being made to improve the neutrino flux. An experiment being set up with the alternating-gradient synchrotron is also described. The neutrino flux should be higher than that at CERN by a factor of 4, and it is likely that the question of the existence of 2 kinds of neutrinos can be settled. A higher-energy machine would be advantageous for the production of intermediate bosons, for increased neutrino intensity, and for the production of high-energy muon beams. (M.P.G.)

20581 (UCRL-10022(p.151-62)) CLASSIFICATION OF MANY-PARTICLE STATES. Kenneth M. Case (Michigan. Univ., Ann Arbor).

The problem of classification of n-particle states is presented in group-theoretical terms. As an introductory example, a proof of the selection rule stating that a spin-1 particle cannot decay into 2 photons is constructed and then translated into the language of group theory. The philosophy of classification schemes is discussed, and a general approach to classifying many-particle states is outlined. Important results obtained to date are sum-

marized. In particular, the group, E_3, and the inhomogeneous Lorentz group are discussed, and Pais's scheme for classifying states involving many π mesons is described. (M.P.G.)

20582 (UCRL-10022(p.163-7)) SYMMETRIES AT HIGH ENERGIES. Frederick Zachariasen (California Inst. of Tech., Pasadena).

Conventional renormalizable field theories and the behavior of the perturbation-series solutions of such theories are used to study symmetries at high energy. An example is presented of how it might be possible experimentally to observe bare (i.e., without electromagnetic renormalizations) masses and coupling constants to see if there is any relation between these quantities for different particles. The discussion is based on pions and nucleons, which are presupposed to be elementary particles. (M.P.G.)

20583 (UCRL-10022(p.167-90)) CALCULATION OF PARTICLE FLUXES FROM PROTON SYNCHROTRONS OF ENERGY 10 TO 1000 Gev. Giuseppe Cocconi (Cornell Univ., Ithaca, N. Y.); Louis J. Koester (Illinois. Univ., Urbana); and Donald H. Perkins (Bristol Univ., England).

Empirical rules suggested by cosmic-ray data were used to calculate pion and proton fluxes from high-energy synchrotrons. Two separate approaches were used. In the first method, a pion (or proton) energy spectrum in the laboratory system was guessed at and combined with the transverse momentum distribution to obtain an expression for the pion flux in analytical form. In the second method, an exponential longitudinal momentum distribution in the center-of-mass system was assumed. Combination of this distribution with that of $p_\perp$ yielded the c.m. momentum distribution and, by a Lorentz transformation, the lab momentum spectrum. Proton fluxes were computed in the same way. In the analytical method, an exponential energy function was chosen, and reasonable agreement in the shape of calculated and experimental curves was obtained. In the second method, calculated and experimental data were also compared. Computed fluxes for pions at 300- and 1000-Bev and 1000-Bev incident protons are presented. The 2 methods of estimating pion fluxes appear to be in good agreement for energies high enough so that the particles projected backwards in the c.m. system do not contribute. (M.P.G.)

20584 (UCRL-10022(p.191-3)) SUMMARY OF DISCUSSION OF PERIPHERAL COLLISION THEORY. Daniele Amati (European Organization for Nuclear Research, Geneva); Geoffrey F. Chew (California. Univ., Berkeley. Lawrence Radiation Lab.); Steven G. Frautschi (California. Univ., Berkeley); and Charles J. Goebel (Wisconsin. Univ., Madison).

A potentially quantitative framework for describing strong interactions at high and low energies is emerging from the combined properties of unitarity and analyticity of the S matrix. The new approach divides each particle into "shells," the outermost of which comprises the bulk of the "geometrical" cross section and is dominated by pions in a configuration controlled by low-energy considerations. Quantitative predictions may be possible about high-energy collisions of impact parameter $\sim 10^{-13}$ cm in terms of the low-energy interaction of pions with the incident as well as the final particles in question. The "peripheral" approach should be capable of describing the majority of the observed strong-interaction phenomena, since experiments indicate that large-impact-parameter collisions do predominate. The S-matrix description of a large-impact-parameter (1-pion-exchange) collision is discussed. Detailed quantitative calculations are expected to be based on this description, predicting total and elastic cross sections and the multiplicity and distribution of produced particles. Higher-energy accelerators are expected to be useful in verifying the predictions, since clear-cut predictions will apply to the "asymptotic" region, where low-energy irregularities have disappeared. Some conjectured qualitative predictions on elastic scattering and mutiple production are presented to illustrate the kind of experiments that may be desirable. (M.P.G.)

20585 (UCRL-10022(p.194-203)) A PRELIMINARY STUDY OF ENRICHED HIGH-ENERGY ANTIPROTON BEAMS. Gerson Goldhaber and Sulamith Goldhaber (California. Univ., Berkeley. Lawrence Radiation Lab.).

The difference in total energy loss between pions and protons due to the relativistic rise can be utilized to obtain enriched antiproton beams for momenta of ~3 Bev/c to ~10 Bev/c. The principal elements for obtaining an enriched antiproton beam are a magnet system of high dispersion leading to a focused beam, a suitable absorber placed at the first focus (pions will have lost more energy than protons and will emerge with lower momentum), and a second magnet, which cancels the dispersion in the first system and gives 2 spatially separated foci for antiprotons and pions. The properties of absorbers of Xe gas, Cs metal, and NaI melted salt are tabulated. In an absorber, the conditions of multiple scattering and density effect must be optimized. Calculated momentum distributions of pions and antiprotons after traversing a Cs absorber are shown graphically. The effects of the initial $\bar{p}/\pi^-$ ratio, the interaction cross sections of $\bar{p}$ and π^-, multiple scattering, and image size are discussed. Estimates of the transmission of the separation system for antiprotons and the final $\bar{p}/\pi$ ratio are made. The proposed separation scheme can also be used to separate π^+ mesons in the momentum region of 2.5 to 10 Bev/c. (M.P.G.)

20586 (UCRL-10022(p.204-13)) SOME THOUGHTS ON BEAM INTENSITY IN A 300-Gev SYNCHROTRON. Kjell Johnsen (European Organization for Nuclear Research, Geneva).

Two proposed injection methods for a high-energy synchrotron are injected from a linac directly into the synchrotron and use of a booster synchrotron between the linac and the big synchrotron to inject a number of pulses given by the ratio of the radii of the 2 synchrotrons. A third injection method is described and its feasibility is investigated. The method consists of operating the synchrotron at $\frac{1}{10}$ its full energy with a 10-times greater repetition rate to gain an order of magnitude in intensity. If a linac can be made with a high repetition rate, the gain in intensity can be brought up to full energy by the stacking of 20 to 50 pulses before acceleration. The means of stacking in the synchrotron is described in detail. The main r-f system for the synchrotron, the bunch size of the injected beam, and space-charge limitations of intensity are also considered. The proposed method is compared with single-turn and multiturn injection from a linac and multipulse injection from a synchrotron. The scheme with linac injection and stacking seems to be the most promising method of obtaining extremely high beam intensities and requires a rather modest current from the linac. However, severe requirements on the performance of the linac and the inflector are imposed. (M.P.G.)

20587 (UCRL-10022(p.214-19)) NOTES ON MISCELLANEOUS EXPERIMENTAL TOPICS. Lawrence W. Jones (Michigan. Univ., Ann Arbor).

Several unrelated experimental problems with a 300-Bev

synchrotron are considered. Synchrotron radiation was investigated as a means of identification of very high-energy particles of the same momentum. It was found that the effect is not sufficiently large to be useful, but it comes close. Synchrotron radiation can be effective in removing electrons from beams. The use of a gas-filled (argon-CO_2) proportional counter in a high-energy well collimated beam instead of a gas-scintillation counter and the use of a scintillation chamber as a terminal detector beyond a complex of spark chambers are discussed. Two neutrino detectors for second-generation experiments are proposed: an iron-plate magnetic-field spark chamber with a total length of ~4m and weight of ~35 tons, and a spark chamber with aluminum plates in the form of flat tanks containing liquid hydrogen. Seventy "plates" would constitute a spark chamber containing 2 metric tons of liquid H with overall dimensions of 2 × 2 × 8 meters. Interaction rates of colliding beams of particles, which could be obtained with storage rings operated in conjunction with a high-energy synchrotron, were calculated. The results indicate that consideration might be given to building a 200-Bev synchrotron plus storage rings rather than a 300-Bev synchrotron without rings, or at least to provide for expansion of an accelerator site to include storage rings at a later date. (M.P.G.)

20588 (UCRL-10022(p.220-1)) KINEMATICS OF 90-Gev p-p INTERACTIONS. Gerald R. Lynch (California. Univ., Berkeley. Lawrence Radiation Lab.).

Polar plots of the envelopes for pions and for protons coming from 90-Bev proton-proton interactions are presented. The plots show that, if one confines oneself to a study of particles emitted backward in the center-of-mass system, all particles with a transverse momentum less than 1 Bev/c have a lab momentum of less than 10 Bev/c. Particles with transverse momenta of 3 Bev/c will have lab momenta less than 25 Bev/c. Therefore, quite accurate momentum and angular distributions for particles from high-energy proton-proton interactions can be obtained with bubble-chamber techniques. (M.P.G.)

20589 (UCRL-10022(p.222-30)) HIGH-ENERGY NEUTRINO BEAMS FROM A 300-Gev SYNCHROTRON. Donald H. Perkins (Bristol Univ., England).

Neutrino fluxes that could be obtained from a 300-Bev accelerator are estimated. The production of neutrino beams with good momentum resolution over a wide energy range is discussed. Assuming an internal beam of 10^{12} protons/sec and a pion flight path of the order of 400 to 1000 m, it is estimated that the counting rate for neutrinos of energy 10 to 50 Bev would be of the order of 1/hr/ton of detector. K mesons would provide a small background spectrum which should not be troublesome and would be difficult to eliminate. It is concluded that investigations of neutrino cross sections with energy up to 50 Bev should be relatively straightforward. Detailed analyses requiring counting rates well above 1/ton-hr do not seem possible. (M.P.G.)

20590 (UCRL-10022(p.231-3)) OPTIMIZATION OF PION BEAMS FOR A HIGH-ENERGY ACCELERATOR. Donald H. Perkins (Bristol Univ., England).

An analysis is performed to determine the optimum energy at which a 300-Bev accelerator must run in order to achieve the most intense pion beam at a particular energy. An expression for the pion flux is derived and fitted to experimental data. Good enough agreement was obtained to justify extrapolation to higher energies. Optimum accelerator energies for pion beams of 5, 10, 25, and 45 Bev are 16, 40, 137, and 300 Bev, respectively. The variation in intensity of the secondary pion beam with primary proton energy is tabulated. The main conclusion is that there is little to gain by having a circulating beam with a widely variable energy. (M.P.G.)

20591 (UCRL-10022(p.234-9)) ELECTROMAGNETIC PARTICLE SEPARATORS FOR A 100- TO 300-Gev ACCELERATOR. Fred H. Schmidt (Washington. Univ., Seattle).

The use of linear crossed-electric-and-magnetic-field velocity selectors in secondary beams produced by a high-energy proton accelerator is discussed. The transmission by electromagnetic separators is small, but multiple gaps can be used to increase the transmission. A gap of 0.1 in. was chosen to permit an electric field of 5×10^7 volts/m. Calculations show that to obtain a separation of 2.79 mm for charged K particles from a K,π beam with a particle momentum of 100 Bev/c, the velocity selector must be 1 km in length. This length presents a severe alignment problem, although it might be possible to make the selector in sections and align each section separately. The required electric field stability for a selector of 1 km length is $\Delta\epsilon/\epsilon < 10^{-5}$, which is probably hopeless to achieve. For beams with particles of momenta of 25 Bev/c, the selector length should be 125 m and the electric field stability $\Delta\epsilon/\epsilon < 6 \times 10^{-4}$. The problem of field stabilization may be eased by a system in which the ratio of electric and magnetic fields is stabilized and which utilizes superconducting magnet coils. The momentum acceptance of the selector can be made large for equal-mass particles, and a possible scheme is proposed by which parallel beams of different momentum can be directed into the separator simultaneously. Separated beam intensities are estimated for several lengths of separator. It is concluded that a 25-Bev/c separator is well within technical grasp by present-day techniques. (M.P.G.)

20592 (UCRL-10022(p.240-3)) REPORT ON THE CAPABILITIES OF BUBBLE CHAMBERS IN ULTRA-HIGH-ENERGY EXPERIMENTS. George H. Trilling (California. Univ., Berkeley. Lawrence Radiation Lab.).

The results of calculations on the capabilities of bubble chambers for the study of the interactions of particles in the 100-Bev range are presented. Under a given set of assumptions, fractional momentum measurement errors and angular errors are calculated and tabulated. Particle identification by means of bubble counting is studied and found to be feasible, possibly, in chambers filled with propane-freon mixtures. The utility of non-hydrogen chambers for studying high-energy interactions is considered briefly. Strange particles can be identified, in principle, by observation of their decays in the chamber, if the very-small characteristic angles can be measured with good accuracy. It is concluded that it is feasible to obtain accurate quantitative information from bubble-chamber experiments at ultrahigh energies, but bubble-chamber techniques must be developed to their limits. (M.P.G.)

20593 (UCRL-10022(p.244-50)) HIGH-ENERGY PROTON LINEAR ACCELERATORS. William Walkinshaw (Gt. Brit. National Inst. for Research in Nuclear Science. Rutherford High Energy Lab., Harwell, Berks, England).

The basic design principles of a high-energy proton linear accelerator are reviewed. The effect of beam loading, resonant vs traveling-wave systems, and calibration and control systems are discussed in detail. It is agreed that a proton linear accelerator can be built, but, because it consists of many independent tanks, considerable care

is required to control the field amplitudes and phases of the tanks. It is concluded that, for high current loading, a resonant system is preferred throughout. High fields and high frequency at 200 Mev produce coupling between the radial motion and the phase motion, imposing tight tolerances on both field amplitude and phase. It may be desirable to work at a lower frequency than 1200 Mc, for energies from 200 to 600 Mev. (M.P.G.)

20594 (UCRL-10572) PHYSICS DIVISION SEMI-ANNUAL REPORT, MAY 1962 THROUGH OCTOBER 1962. (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 28, 1962. Contract W-7405-eng-48. 121p.

Research is reported on pion beta decay, neutron polarization in π^- + p charge-exchange scattering, π-π interactions, plastic scintillator detection efficiency for 4 to 76-Mev neutrons, K^+ and K^0 decay, K^+-p interactions, meson exchange and K^* spin alignment in K^+ + p reactions, beta decay of hyperons, π-π resonances, π^+-p scattering, neutron polarization from Σ decay, the muonic decay rate of the lambda hyperon, sigma-hyperon production, lambda lifetime, double hyperon production in D, three and four-pion mass spectra, pion production in π-p interactions, nuclear excitation from μ^- capture, proton polarization in elastic π-p scattering, phase-shift analysis in π-p scattering, radiative capture of π^- in flight, polarization in nuclear scattering of 740-Mev protons, K^--p interactions, mesic x rays, bound muon decay, meson production in p + d collisions, K^- reactions in complex nuclei, hyperfragment production processes, π^0 mean life, 16-Bev π^- interactions with protons, multiple scattering of heavy ions, charged particles from O^{16} interactions and mirroring of geomagnetically trapped protons on satellites. Bubble chamber development, operation, and research are included. Theoretical work dealt with s-matrix and elementary-particle theory, lepton physics, nuclear theory, atomic and plasma physics, liquid He, particle orbit theory and accelerator design problems, complex angular momentum, Regge poles, dispersion relations, and various other topics. Many computer programs were written, and data handling systems were developed. Construction of a video track analyzer is reported, and accelerator development and operation are summarized. 139 references. (D.C.W.)

20595 (USNRDL-TR-612) HYDRA PROGRAM—DETERMINATION OF THE TOTAL THERMAL RADIANT ENERGY EMITTED BY AN UNDERWATER EXPLODING WIRE. J. S. Hege (Naval Radiological Defense Lab., San Francisco). Jan. 10, 1963. 33p. (DASA-1344)

The total thermal radiation from an underwater spark has been determined by the measurement of the absolute radiation at two wave-lengths as a function of time. Planck's law for thermal radiation was applied. Values for the rates of total thermal radiation and values for the spark temperatures and radii were tabulated and graphed as functions of time for three explosions under three different sets of conditions. Total thermal radiation was obtained by graphically integrating the rate of thermal radiation over the time of the process. For two of the three explosions approximately 30 percent of the spark energy was emitted as thermal radiation. It was not possible to determine this fraction for the third explosion. Analysis of the propagation of error shows that the error in the results for total thermal radiation is less than 7.5 times any error in the measurements of the radiation incident on the photoelectric tubes. (auth)

20596 (AEC-tr-5767) ABSOLUTE CHARACTERISTIC CURVES OF MASS SPECTROGRAPHIC PHOTOGRAPHIC MATERIALS FOR POSITIVE IONS. W. Rudloff. Translated for Ames Lab., Ames, Iowa from Z. Naturforsch., 17a: 414-21(1962). 16p.

The complete and absolute characteristic curves of five different commercial gelatin-poor emulsions were measured for various ion masses in the mass range 2 to 40 at 9 kev. Results indicated that the emulsions behaved as single-grain layers, and no deviation from the reciprocity law could be established within the scatter of the experimental points. (J.R.D.)

20597 (FTD-TT-62-958) TRANSACTIONS OF THE PHYSICS INSTITUTE. D. V. Skobel'tsyn, ed. Translation of Tr. Fiz. Inst., Akad. Nauk SSSR, 10: (1958). 247p.

Three papers on the theory of flow of supersonic gas, on the derivation of hydrodynamic equations with account of radiation, and on the principles of a theory developed for a 10-Bev proton synchrotron are presented. Abstracts were prepared for the last two papers. 58 references. (D.C.W.)

20598 (FTD-TT-62-958(p.20-30)) HYDRODYNAMIC EQUATIONS WITH ACCOUNT OF RADIATION. S. Z. Belen'kii (Belen'kiy). (Translation).

Starting from the laws of conservation of energy, matter, and momentum, hydrodynamic equations taking radiation into account are derived. Similar equations are obtained by starting from the energy-momentum tensor for a system consisting of an aggregate of particles and radiation. The equations developed are compared with equations derived by other workers. (D.C.W.)

20599 (FTD-TT-62-958(p.31-243)) PRINCIPLES OF PROTON SYNCHROTRON THEORY. M. S. Rabinovich. (Translation).

Principles of a theory developed for a 10-Bev proton synchrotron are discussed. Radial-phase oscillations occurring when particles move in an accelerator with a slotted magnet are investigated. Singularities of motion, stability criteria, and acceleration in multiple resonance are considered. Fast particle oscillations are also treated. Influence of the linear gaps on the injection and the capture of particles in the accelerator mode are analyzed. The concept of the envelope of the particle trajectory is introduced, and particle motion with allowance for the presence of magnetic field in the linear gap is calculated. Influence of magnetic field deviation from the calculated value is also computed. Resonance phenomena between fast and slow oscillations are examined. A special procedure for calculating the resonance phenomena in accelerators with slotted magnets was developed. Fast particle oscillations with account for magnetic field change and the increase in the particles' energies are considered as well as resonances between the high-frequency harmonics of the magnetic field and the phase oscillations. Injection theory is developed, making possible calculations of the number of particles captured into the acceleration mode. Plots show the variation of intensity with variations in accelerator parameters. The envelope method is used in a theoretical study of the free oscillations in strong-focusing accelerators, and a phase equation for a strong-focusing accelerator is derived. (D.C.W.)

20600 SOLID SCINTILLATORS: SOME ASPECTS OF GOVERNING PRINCIPLES, RESEARCH AND ACHIEVEMENTS. G. A. Giger (Department Scintillateurs La Radiotechnique, Suresnes, France). Acta Electronica, 5: 111-30(Jan. 1961). (In French)

Definition of the term and of the properties of the substances referred to as scintillators are followed by a brief outline of background showing the relative maturity of their

discovery. Schematic summarization of the mechanism of operation assists in understanding the composition and production, as well as the use of scintillators. The more current applications are mentioned, and other possible applications are indicated, in which scintillation detectors could replace presently used equipment advantageously. Finally, a discussion is given of the direction taken by research. (auth)

20601 DISLOCATIONS IN THE PRIMARY SLIP SYSTEMS OF FACE-CENTERED CUBIC CRYSTALS. L. J. Teutonico (Republic Aviation Corp., Farmingdale, N. Y.). Acta Met., 11: 391-7(May 1963).

Application is made of the anisotropic elastic analysis of uniformly moving dislocations to study the dynamical behavior of dislocations in the primary slip systems of f.c.c. crystals. Both edge and screw dislocations in the (112) and (110) orientations on the {111} plane are considered in detail. For various f.c.c. elements, numerical solutions are obtained for the force between two parallel dislocations as a function of velocity. Calculated values are presented of: (1) the threshold velocity at which the force vanishes, and (2) the limiting velocities of both edge and screw dislocations. These calculations determine the extent of the velocity range of anomalous behavior for the different dislocation interactions. Since the dislocations of interest usually exist as two partial dislocations separated by a stacking fault, numerical solutions are also obtained for the force between the two partials as a function of velocity for both extended edge and screw dislocations. In addition to the calculations for the f.c.c. elements, similar calculations are also made for a series of fictional f.c.c. materials. As a result, a number of correlations are obtained between elastic constant values and dynamical behavior. (auth)

20602 ON THE APPROXIMATE APPLICABILITY OF THE SCHRÖDINGER EQUATION TO NON-ISOLATED SYSTEMS. Bronisław Średniawa and Jan Weyssenhoff (Jagellonian Univ., Krakow). Acta Phys. Polon., 23: 177-88(Feb. 1963). (In English)

Problems in which Schrödinger's equation with time-dependent hamiltonian is applied to one system should rather be considered as representing cases of two systems, the second acting appreciably on the first but not inversely; the systems as a whole is then considered to be isolated and, consequently, subject to treatment by means of a Schrödinger equation with time-independent hamiltonian. The composition and decomposition of systems is dealt with by the method of statistical operators of v. Neumann. Both methods of dealing with the problem are shown to lead in good approximation to the same results, but only for times fulfilling a given inequality. (auth)

20603 SYMPOSIUM ON THERMIONIC POWER CONVERSION, MAY 1962, COLORADO SPRINGS, COLORADO. John Blair, J. J. Connelly, G. M. Grover, et al., eds. Advan. Energy Conversion, 2: 1-643(July-Sept. 1962).

Twenty-eight papers presented at the symposium are included. Separate abstracts were prepared for twenty-six; two have been previously abstracted in NSA. (A.G.W.)

20604 EXPERIMENTAL OPTIMIZATION OF CESIUM VAPOR THERMIONIC CONVERTERS WITH METAL EMITTERS. C. C. Weeks, R. C. Dahleen, and J. E. Gingrich (Atomics International, Canoga Park, Calif.). Advan. Energy Conversion, 2: 315-23(July-Sept. 1962).

Parametric studies are being conducted utilizing both cylindrical fixed-spacing and parallel-plane, variable-spacing thermionic converters. A brief description of the design and fabrication of these converters is given, and the techniques of component preparation, the use of getters and the philosophy of operation are illustrated. The instrumentation for control and measurement of the various parameters is discussed. The emitters of these parallel plane and cylindrical diodes are heated by electron bombardment. Constant power input is achieved by using a controller which is insensitive to back heating from the emitter. The load which is used with these diodes can be varied to produce the full operating range from reverse currents to the applied voltage region. At the higher emitter temperatures, surface ionization appears to be sufficient for space charge neutralization. Under these conditions the power density of a converter, operated at constant emitter temperature and optimum cesium pressure, increases as the spacing is decreased. At lower emitter temperatures, approximately 1450°C and less for molybdenum, surface ionization is insufficient to neutralize the space charge. Thus, the additional ions must be supplied from volume ionization, resulting in an optimum spacing for maximum power densities. Curves showing power densities, optimum cesium pressures, and optimum collector temperatures versus spacing for the variable spacing diode are given and discussed. Efficiency curves for several refractory emitters are given. The effects of the individual optimization of cesium pressure, collector temperature, and load resistance are shown for both "ignited" and "unignited" modes of operation. (auth)

20605 EXPERIMENTAL MEASUREMENT AND INTERPRETATION OF VOLT-AMPERE CURVES. J. E. Gingrich, C. Warner, and C. C. Weeks (Atomics International, Canoga Park, Calif.). Advan. Energy Conversion, 2: 325-33(July-Sept. 1962).

Cylindrical and parallel-plane cesium vapor thermionic converters were used for obtaining volt-ampere curves for systematic variations of emitter, collector, and cesium reservoir temperatures, with electrode spacings ranging from a few to many mean free paths, and with space charge conditions varying from electron-rich to ion-rich. The resulting curves exhibit much variety. The saturation currents agree well with the data of Houston and Aamodt for the space charge neutralized, few-mean-free-path cases. "Apparent" saturation currents for space charge limited cases were observed and were always less than the currents predicted by Houston and Aamodt. Several discontinuities in slope were observed in the reverse current portion of the curves and these have tentatively been identified with volume ionization of atoms in both the ground and excited states. Similar processes may be important for obtaining the ignited mode. The methods used to measure static and dynamic volt-ampere curves are described. The use of a controlled-current load has yielded a "negative resistance" region in the curves which show the ignited mode. The curves obtained with poor current control do not show this phenomenon. Extinction is considered from the standpoint of Kaufmann's criterion for stability. (auth)

20606 DESIGN AND OPERATION OF LABORATORY TYPE PARALLEL PLANE CESIUM THERMIONIC CONVERTERS. V. C. Wilson and J. Lawrence (General Electric Co., Schenectady, N. Y.). Advan. Energy Conversion, 2: 335-40(July-Sept. 1962).

Two parallel-plane converters are described. Evidence presented suggests that an auxiliary discharge to a guard ring increases the output power of these converters. While driving one tube with a 60 cps transformer, a current of 110 amp/cm^2 was drawn at an emitter temperature of 2000°K and with the collector 1.5 v positive with respect to the emitter. (auth)

20607 CHARACTERISTICS AND LIFE TESTS OF CYLINDRICAL THERMIONIC CONVERTERS. J. Lawrence and V. C. Wilson (General Electric Co., Schenectady, N. Y.). Advan. Energy Conversion, 2: 341-51(July-Sept. 1962).

Three cylindrical thermionic converters with emitters of tantalum, molybdenum, and niobium have been built and are being life tested. They were designed specifically for life tests in air with electron bombardment heating. The dimensions and operating temperatures chosen are considered reasonable for a nuclear reactor application. Design details are presented and output characteristics such as functions of cesium pressure and emitter temperature are given for each converter. All three devices are now operating and have run from 2200–3300 hr. Although they have not yet achieved the normal life of a nuclear fuel element, it is encouraging that no basic failures have been experienced. (auth)

20608 NUCLEAR THERMIONIC FUEL ELEMENT EXPERIMENTS. H. M. Ogle, G. I. Samstad, and C. A. von Damm (General Electric Co., Pleasanton, Calif). Advan. Energy Conversion, 2: 353-61(July-Sept. 1962).

Several in-reactor tests of plasma diodes have been performed at the Vallecitos Atomic Laboratory to gain design information for reactor thermionic fuel elements. These experiments were designed to furnish data in three major areas: (1) comparison of out-of-pile performance and in-pile operation; (2) special diode fabrication techniques required for in-pile operation; and (3) test facility requirements for adequate control of converter parameters. In order to control the variables of interest an in-pile experimental facility has been developed for testing these diodes. A high neutron flux (4×10^{13} nV unperturbed) is available with provisions for controlling and monitoring cathode, anode, and cesium temperatures as well as diode output power. Problems encountered during in-pile tests and solutions that have been employed to solve these problems are discussed. Plasma diodes have been designed to operate in a high neutron flux, and to generate their own cathode heat by fission within the cathode. Several different geometries, materials, and fabrication techniques which have withstood the severe environment of a nuclear reactor have been tested. For example, a number of different methods have been employed for supporting the cathode of the converter. Preliminary findings of these tests are described. (auth)

20609 THERMIONIC CONVERTER EXPERIMENTS. J. H. Ingold, E. Blue, and W. J. Ozeroff (General Electric Co., Pleasanton, Calif.). Advan. Energy Conversion, 2: 363-73(July-Sept. 1962).

The thermionic properties of polycrystalline bulk samples of several refractory metal carbides in vacuo and in cesium vapor have been determined. Some typical Richardson plots of experimental data obtained by a low-field method are shown, and a summary of the results is presented in tabular form. Most of the carbides investigated can be characterized by an emission constant in the range 40–90 amp/cm^2 deg^2 and a work function in the range 4.0–4.2 v. In addition, current–voltage characteristics typical of those obtained for the same carbides immersed in cesium vapor are shown. No gross differences in the cesium characteristics of the different carbides were observed. Finally, current–voltage characteristics obtained for a thermionic converter operating with a collector temperature in excess of 1000°K are shown. A power output of 4.5 W/cm^2 was obtained for a planar Cs-on-Ta converter at an emitter temperature of 2250°K and a collector temperature of 1725°K. (auth)

20610 RESEARCH ON CESIUM-VAPOR CELLS EMPLOYING CARBIDE CATHODES. Hugh L. Garvin (General Atomics Div., General Dynamics Corp., San Diego, Calif.). Advan. Energy Conversion, 2: 375-87(July-Sept. 1962).

The status of a research program is reported in which the performance of cesium-vapor thermionic cells employing carbide emitters is being studied. Vacuum emission measurements were made on a series of samples, which were polycarbides of uranium and zirconium. Certain of these carbides were incorporated into parallel-plane cesium cells in which studies were made of the electrical output characteristics. Results indicated that the cells operate in a discharge mode for cesium pressures exceeding 0.1 mm Hg and that maximum power output decreases linearly as the interelectrode spacing increases. (auth)

20611 ACTIVATION PHENOMENA IN URANIUM-BEARING EMITTERS. G. A. Haas (Naval Research Lab., Washington, D. C.). Advan. Energy Conversion, 2: 389-90 (July-Sept. 1962).

Activation effects in the thermionic emission of various uranium compounds appear to be caused by the formation of free uranium on the surface of the emitter. (auth)

20612 ANALYSIS AND NUMERICAL SOLUTIONS TO THE SPACE-CHARGE POTENTIAL PROBLEM IN LOW-PRESSURE THERMIONIC CONVERTERS. R. G. McIntyre (Texas Instruments Inc., Dallas). Advan. Energy Conversion, 2: 405-16(July-Sept. 1962).

The problem of space-charge potential distribution in a diode is considered for the case where limitations are counteracted by the introduction of ions at the emitter. The no-collision approximation is used, in which inelastic and short-range elastic collisions are neglected and each particle interacts with the Coulomb field of all the other particles. The electrostatic potential is determined, in a self-consistent manner, from Poisson's equation. The equations are simplified by transforming to reduced variables in a manner described by Langmuir and others. There are eight important cases, each describing a different type of spatial variation of potential in the emitter-collector interspace. Numerical solutions are presented showing the character of these potential shapes. For the cases of monotonic potential functions, for spacings on the order of Auer's characteristic distance, the curves are very nearly linear. For slightly wider spacings the curves begin to bend over until, finally, there clearly exist emitter and collector sheathes separated by a wide region at uniform potential. In the two cases where the potential reaches an extremum but does not return to zero, the results show an emitter sheath backed up by a region rich in the opposite sign. As spacings are increased an oscillatory solution with regions alternately rich in ions and electrons is found. For cases where the potential reaches an extremum and passes through zero to a collector potential of the opposite sign the results show a double sheath at the emitter and a simple sheath at the collector separated by a wide region of essentially uniform potential between zero and the collector potential. For certain collector potentials an extremum of the same sign but larger than the collector potential in absolute value also is found. In these cases, for wide spacings, one again finds spatially oscillatory solutions. The cases are found to be uniquely determined by the anode potential and the degree of space charge neutralization provided for. There appears no overlap of the cases. Smooth transitions are found in making a change in the externally controlled parameters. (auth)

20613 A PLASMA-SHEATH THEORY FOR NOBLE GAS THERMIONIC CONVERTERS. C. B. Leffert (General Motors Corp., Warren, Mich.). Advan. Energy Conversion, 2: 417-36(July-Sept. 1962).

A plasma-sheath theory is described for computing the V-I characteristics of noble gas thermionic converters.

Application of this theory in the form of an IBM computer code to laboratory and in-pile experimental data is presented. The assumptions in the theory are twofold: (1) a spatially uniform ion density is assumed in the interelectrode plasma between the emitter and collector sheaths; and (2) the ion loss rate is taken to be independent of the diode voltage. The basic plasma-sheath equations are presented, and the operation of the computer code to produce the theoretical voltage-current characteristics is outlined. The experimental data from the operation of laboratory and in-pile thermionic converters are analyzed by adjusting plasma parameters to fit the theoretical to the experimental voltage-current characteristics. A reasonable fit of the theoretical curves to the experimental curves is obtained. It was found that the ion density in the plasma varies considerably with the diode voltage. The effects of such variables as volume recombination of ions, plasma resistivity, and tube geometry on the voltage-current characteristics are discussed. The general V-I characteristics obtained from the code for a Gabor-type triode are described. The results show a significant increase in the ratio of the output current to the ion source rate for a large collector to emitter area ratio not only for the plasma limited case but also for the power producing region of the emission limited case. (auth)

20614 A PRELIMINARY ANALYSIS OF THE ARC MODE CESIUM CONVERTER. T. Jarvis (Ford Instrument Co., Long Island City, N. Y.). Advan. Energy Conversion, 2: 437-46 (July-Sept. 1962).

Thermionic converter operation has previously been observed to occur with emitter temperatures and work functions too low for surface ionization. In addition, discontinuities and quasi-stable operation were observed. A qualitative identification of this type of operation with the low voltage arc is made. Analysis of the arc requires solution to the three fundamental problems of ionization mechanism, thermalization, and energy balance. It is shown that a solution for the first presents an apparent violation of the third. Analysis of thermalization indicates that processes more rapid than the usual collective interaction must occur. In particular, Maxwellian electron energy distribution close to the collector, or the "Langmuir Paradox," indicates the need for an oscillatory interaction mechanism. A brief discussion of possible arc models is given together with a review of techniques for obtaining the temperatures and densities within the arc plasma. (auth)

20615 THE SURFACE IONIZATION AND VOLUME IONIZATION MODES OF OPERATION IN THE THERMIONIC PLASMA ENERGY CONVERTER. M. E. Talaat (Martin Marietta Corp., Baltimore). Advan. Energy Conversion, 2: 447-58 (July-Sept. 1962).

The plasma diffusion equations for electrons and ions, Poisson's equation, the continuity equations, and the proportionality assumption are examined and solutions are obtained for two cases: (1) when the ions are primarily produced at the emitter electrode surface, and (2) when important volume ionization exists in the interelectrode space. These solutions are then used to examine typical examples of the two modes of operation of the thermionic plasma energy converter. One, the surface ionization mode of operation, is characterized by an output current density that represents a fraction of the Richardson saturation current density and the second mode, the volume ionization mode of operation, is characterized by an output current density approximately an order of magnitude higher than the surface ionization current density. It is shown that for the surface ionization mode of operation the current density at maximum power is proportional to the electron density at the emitter sheath edge, is proportional to the mean free path of the electron, and is inversely proportional to the interelectrode spacing. When the electron temperature is raised by going toward short circuit conditions, high volume ionization takes place and a new stable operating region may be reached when the electron temperature is such that the generated ion density in the interelectrode space gives rise to a high electric field ϵ at the emitter surface (due to the plasma ions reaching the emitter surface from the plasma region). The high volume ionization mode of operation is maintained as long as the energy balance equation is satisfied at the high electron temperatures necessary for maintaining the high plasma ion current density collected by the emitter electrode. The plasma ion current density reaches, in typical examples, values which are three orders of magnitude greater than the typical ion current density generated by surface ionization (the Saha-Langmuir equation). The latter current density is symptomatic of the surface ionization mode of operation. The transition from volume ionization mode to surface ionization mode is reached when the electron temperature necessary for adequate volume ionization does not satisfy the energy balance equation. (auth)

20616 SPACE CHARGE ANALYSIS OF THE CESIUM-FILLED THERMIONIC DIODE. C. Warner (Atomics International, Canoga Park, Calif.). Advan. Energy Conversion, 2: 459-65 (July-Sept. 1962).

The space charge problem for a plane diode whose hot cathode emits both ions and electrons has been considered by Hernqvist and Johnson and by Auer. This model is appropriate for the analysis of the low-pressure cesium-filled thermionic converter in which the ions are generated by surface ionization at the cathode. Further, the electrode spacing must be such that the assumption of no collisions is valid. The variety of potential distributions that can arise is described, but few numerical results are given. The numerical results of machine calculations for potential distributions with various ratios of emitted electron to emitted ion density, electrode spacings, and applied potentials are systematized and discussed. Some analytical results, e.g., the necessary and sufficient conditions for the establishment of certain types of potential distributions, are given. Some typical theoretical V-A curves are compared with experimental data. (auth)

20617 THE ENERGY DISTRIBUTION FOR ELECTRONS IN A THERMIONIC DIODE PLASMA CANNOT BE TRULY MAXWELLIAN. W. B. Nottingham (Massachusetts Inst. of Tech., Cambridge). Advan. Energy Conversion, 2: 467-79 (July-Sept. 1962).

For the refractory emitters such as tungsten, tantalum, and molybdenum operated in an energy conversion diode, the ratio of the emitter temperature to the cesium temperature strongly influences the operating properties. If this ratio exceeds 3.2 an ion-rich sheath usually forms at the emitter surface. Electrons are accelerated in the plasma space by this injection potential. The analysis given here shows that at the open circuit condition, the energy distribution of the electrons at the plasma edge of the emitter sheath cannot be a true Maxwellian over the entire range in electron energy. Instead, it is thought to be made up of two quasi-Maxwellians. The low energy electrons are trapped and may have a high average energy close to that of the injection potential. The untrapped electrons will have an electron temperature equal to that of the emitter and their density will be that associated with an apparent or fictitious density many times that of the actual density.

The theory is developed to describe quantitatively the relations that must be satisfied for the above description to apply. Typical numerical results applicable to specific diode configurations are presented. It is concluded that if the emitter to cesium temperature ratio exceeds 3.6, volume ionization is not required for a stable sheath. In the range 3.2–3.6 surface ionization is usually insufficient and it is necessary to have volume ionization to sustain the sheath. Further studies will be required to establish the mechanism. It may be direct ionization by high energy electrons or ionization from excited states of the cesium atoms. (auth)

20618 THE TRANSITION TO THE ARC MODE AND ITS INFLUENCE ON THERMIONIC CONVERTER PERFORMANCE. H. L. Steele and R. B. Gillette (Boeing Co., Seattle). Advan. Energy Conversion, 2: 483-97(July-Sept. 1962).

Several investigators have reported that a thermionic converter with a given emitter temperature can operate in either a high current or a low current mode. In earlier published work, the high current mode was attributed correctly to volume ionization. At that time, the conclusion that volume ionization was occurring was based on the appearance of a glow in the space between emitter and collector as the voltage of the collector was made more positive. The discontinuity in the volt-ampere curve at this breakdown voltage is very definite. The phenomenon was studied irrespective of whether it occurred in the power quadrant or with a positive potential applied to the collector. A detailed analysis of this phenomenon now can be presented. At low emitter and low cesium control temperatures breakdown occurs when a potential drop near the collector is equal to the ionization potential of cesium. At the high emitter and high cesium control temperatures, the breakdown occurs at higher currents with potential drop as low as 2 v. This indicates that ionization of excited cesium atoms is occurring when the converter is operating in the power quadrant. The V-A curve in the arc mode is logarithmic, and the voltage at which maximum power occurs is equal to the voltage equivalent of the electron temperature. It will be shown that electron temperature increases with cesium pressure. The short-circuit current in the arc mode was measured and compared with a new theory of the condition which determines if a given converter is operating electron-rich or ion-rich. The current output in the volume ionization mode is surprisingly independent of emitter temperature. This fact is especially important where series operation will be required, since it will be difficult to maintain the same emitter temperatures in all diodes. The higher efficiency obtainable in the high current mode and the relative independence of emitter temperature may help to accelerate the development of thermionic systems. (auth)

20619 LOW TEMPERATURE CESIUM PLASMA CONVERTER. W. Stenzel and M. Bernstein (Ford Instrument Co., Long Island City, N. Y.). Advan. Energy Conversion, 2: 499-521(July-Sept. 1962).

Measurements of space potentials, electron temperatures, electron concentrations, and electron energy distributions were made, with the aid of plane Langmuir probes by means of a pulsed technique developed by Waymouth, inside the discharge of low-temperature cesium plasma converters operating at an emitter temperature of 1500°K and a cesium temperature of 200°C. Data obtained at the center of the discharge showed electron temperatures of about 10,000°K, concentrations in excess of 10^{12} electrons per cm^3, and space potentials more than 1 v above the collector potential under normal operating conditions. The electron energy distributions were strictly Maxwellian. Adjustable probes were used to obtain variations of the parameters along the axis of the discharge. Their results showed that a "virtual collector" exists a short distance from the emitter surface whose potential is from 1.1–1.5 v above the collector potential with respect to the emitter. The potential curve then remains essentially flat within the main part of the discharge, the plasma region. The electron concentration has a sinusoidal variation, reaching a maximum near the center and having magnitudes between 10^{12} and 10^{13} electrons per cm^3. The electron energy distributions are Maxwellian in the center of the plasma, but exhibit an excess of high energy electrons near both electrodes. The electron temperature rises to a maximum above 10,000°K near the emitter and falls toward the collector. A simple physical picture of the discharge is developed, and it is shown that a one-step ionization process by the high energy tail of the electron distribution is sufficient to explain the degree of ionization required to maintain the discharge. Phenomena taking place at the collector surface are analyzed. One possible mechanism is developed which can lead to electron distributions of the same nature as is observed in front of the collector. This mechanism is also shown to aid in the explanation of the so-called "Langmuir paradox." (auth)

20620 ELECTROSTATIC PROBE MEASUREMENTS IN A CESIUM PLASMA. R. H. Bullis (United Aircraft Corp., East Hartford, Conn.). Advan. Energy Conversion, 2: 523-6(July-Sept. 1962).

Electrostatic probe measurements have been made in a cesium plasma with an electron number density of $10^9/cm^3$ generated in a thermionic converter operating in the non-arc mode condition. Experimental results obtained using a conventional electrostatic probe with borosilicate glass as the electrical insulating material around the probe shank indicate that there is both surface and bulk electrical conduction through this material when it is placed in a high temperature cesium plasma. This surface leakage significantly changes the current-voltage characteristics of the probe so that the correct plasma properties cannot be obtained from this information. Tests of several other electrical insulating materials indicated that similar problems with electrical conduction were present when the probe was inserted in the cesium plasma. A novel probe design is described, which is comprised of a coaxial metal cylinder sandwiched between two layers of insulating material around the probe shank. By maintaining this coaxial cylinder at the same potential as the probe, the cylinder acts as a guard ring and prevents both surface and bulk electrical leakage. A comparison is presented of the experimental results obtained from measurements of the same cesium plasma with the two different probes. An electron temperature of 0.18 ev is measured with the coaxial probe where the emitter temperature corresponds to 0.12 ev. A measured electron to ion saturation current ratio of 616 is obtained with the coaxial probe where a saturation ratio of 494 would be expected in a thermalized cesium plasma. These results, when compared with an electron temperature of 0.68 ev and saturation ratio of 1.4 obtained with a glass shielded probe, are more consistent with existing converter conditions. (auth)

20621 EXPERIMENTAL STUDIES OF THE EMISSION AND DISCHARGE CHARACTERISTICS OF THE Ta–Cs SYSTEM. M. D. Gibbons (General Electric Co., Schenectady, N. Y.). Advan. Energy Conversion, 2: 527-43(July-Sept. 1962).

Emission and discharge measurements made on a Cs–Ta emitter in a tube with parallel electrode geometry and with an adjustable emitter-collector spacing are described. Emission results indicated that this particular Ta–Cs emitter surface has an emission capability greater than that reported by Taylor and Langmuir for Cs–W, while the emission maxima are shifted to lower temperatures. This increase in emission over that usually reported for Cs–Ta is believed due to a preferred orientation of the Ta surface. The large enhancement of the emission during the discharge is believed due to the lowering of the work function by the effective increase in the adsorption of Cs which is due to the increased arrival rate caused by the retarding field for ions. This mechanism is probable in the region where the surface ionization is expected. The discharge studies involve the measurement of the breakdown and maintenance potentials of the hot cathode arc discharge for various emitter-collector spacings, emitter temperatures, and Cs pressures. Corrections for the contact potential and sheath potentials are applied to the experimental data. For a pressure the order of 1 mm, and high emitter temperatures, the results indicate that the magnitude of the emitter sheath potential is close to the first resonance level of Cs. This strongly suggests a multi-step process. (auth)

20622 THE CESIUM VAPOR THERMIONIC CONVERTER. I. LIMITATIONS IMPOSED BY EMISSION PROCESSES. N. S. Rasor (Atomics International, Canoga Park, Calif.). Advan. Energy Conversion, 2: 545-67(July-Sept. 1962).

Performance limits imposed on the thermionic converter by the emission of electrons, ions, atoms, and photons are analytically defined, and their relative importance is appraised. Comparison of the analytical results with experimentally observed performance indicates that emission processes largely determine the required operating temperatures and cesium pressures in cesium diode converters. The performance characteristics and relative usefulness of various classes of emitter materials is estimated, leading to the conclusion that high work function refractory metals with adsorbed cesium have the greatest general utility. Criteria for the choice of emitter materials giving maximum efficiency at a given emitter temperature and spacing in the cesium diode converter are given, as well as relations permitting the choice of compatible emitter and ionizer materials in the surface ionization triode. (auth)

20623 THE CESIUM VAPOR THERMIONIC CONVERTER. II. PATCH AND TRANSPORT EFFECTS. N. S. Rasor, G. N. Hatsopoulos, and S. Kitrilakis (Thermo Electron Engineering Corp., Waltham, Mass.). Advan. Energy Conversion, 2: 569-81(July-Sept. 1962).

Analysis of the electrical characteristics of cesium-vapor diode thermionic converters indicates that nonuniform emission from polycrystalline emitters can account for many of the major observed features of the characteristic behavior. A single crystal emitter showed gross changes in its output characteristics when its surface was etched, suggesting the creation of patches. Using the work function distribution obtained from the electrical characteristics, a simple model for ion emission neutralization permits computation of the saturation currents of the ignited and extinguished modes. The computed values are in semiquantitative agreement with the experimental data reported. Consideration of the energy balance and ion generation requirements for sustaining volume ionization and energy losses in the ignited mode yields expressions for the internal potential drop across the cesium vapor and the electron temperature. Consideration of the simplest of the energy loss contributions shows the assumptions to be consistent with the experimental data reported. (auth)

20624 THE CESIUM VAPOR THERMIONIC CONVERTER. III. OBSERVED DEPENDENCE OF PERFORMANCE ON CESIUM PRESSURE, SPACING, EMITTER TEMPERATURE AND EMITTER MATERIAL. Sotiris Kitrilakis and George N. Hatsopoulos (Thermo Electron Engineering Corp., Waltham, Mass.). Advan. Energy Conversion, 2: 583-600(July-Sept. 1962).

Extensive data obtained on the performance of a cesium vapor diode thermionic converter are described. Volt-ampere characteristics were obtained for four spacings from 0.002–0.019 in., emitter temperatures in about 50° steps from 1600–2050°K, and cesium pressures to 30 torr. A set of such data for emitters of Nb, Ta, Mo, W, Re, and Ir have been obtained. Heat flow through the converter could be measured by an attached calorimeter. A systematic method is described for evaluating the practical significance of this large amount of data to permit the choice of optimum materials and operating points for efficient engineering design. Evidence is presented that the observed saturation current of the extinguished mode represents true temperature-limited emission, and thus may be used to obtain data equivalent to the Langmuir S curves. (auth)

20625 SPACE CHARGE ANALYSIS OF A PLASMA DIODE. K. G. Hernqvist and F. M. Johnson (RCA Labs., Princeton, N. J.). Advan. Energy Conversion, 2: 601-11 (July-Sept. 1962).

A theoretical analysis of the space charge problem for a cesium plasma diode shows that operating conditions can be achieved for which there exists no simultaneous solution of the space charge and converter equations which relate current, voltage, and load impedance. These conditions correspond to those for which internal relaxation oscillations have been experimentally observed in a cesium vapor type thermionic energy converter. Examination of the normalized distance parameter used in the analysis indicates that potential distributions having a large number of potential maxima and minima may exist in the cesium plasma diode. This explains some irregularities found in the load characteristic and in plasma temperature measurements for the plasma diode. (auth)

20626 CESIUM PLASMA TRIODE. B. Devin, J. D. McElroy, and S. Klein (Centre d'Études Nucléaires, Saclay, France). Advan. Energy Conversion, 2: 623-30(July-Sept. 1962).

Experiments with Cs plasma triodes have shown three distinct types of oscillations that may be of interest in energy conversion work. One mode of operation is analogous to conventional vacuum triode operation, another is a low frequency mode which exhibits several interesting features, and the third is a way of coupling to the spontaneous plasma oscillations. These modes are presented and are discussed in terms of the ionized medium conditions. (auth)

20627 ELECTRON REFLECTION FROM CESIUM COATED SURFACES. R. J. Zollweg (Westinghouse Electric Corp., Pittsburgh). Advan. Energy Conversion, 2: 631-6(July-Sept. 1962).

The a-c retarding potential difference technique has been applied to the study of the reflection of low energy electrons at surfaces partially coated with cesium. The technique is described and results for polycrystalline copper coated with cesium are given. For primary electron energy of 0.5 ev about 20 per cent of the incident electrons

are reflected while at 1.0 ev about 30 per cent are reflected. (auth)

20628 NOISE IN THERMIONIC CONVERTERS. E. Kuhn (Republic Aviation Corp., Farmingdale, N. Y.). Advan. Energy Conversion, 2: 637-8(July-Sept. 1962).

Emitter activity and patchiness can be assessed from shot noise response curves of shot noise voltage versus emitter temperature, and vapor pressure. Specifically the characteristics (a) temperature and pressure at which the noise sharply increases, (b) the rate of change in the slope of the curve in the transition region between space charge and temperature limited modes, and (c) the level of space charge limited noise can give indications of activity and patchiness at different times of emitter life. These characteristics can be used as a stethoscope to listen and predict trends in emission capabilities as a function of emitter lifetime before the effects are recognized in the output power. Appropriate shot noise sensing can be used as a reliability or quality indicator for electron emission in thermionic converters. (auth)

20629 RF OSCILLATIONS IN NOBLE GAS PLASMA DIODES WITH EXTRANEOUS ION SUPPLY. W. Bloss and B. Saggau (Technische Hochschule, Stuttgart). Advan. Energy Conversion, 2: 639-43(July-Sept. 1962).

R-f oscillations are investigated in neon-filled plasma diodes. The ion density is varied by means of an auxiliary discharge. The results are compared with calculations of Zollweg and Gottlieb. It is shown that there is a reasonable agreement between experimental results and calculations. (auth)

20630 MAGNETOHYDRODYNAMIC FLOW PAST A THIN AIRFOIL. E. Cumberbatch, L. Sarason, and H. Weitzner (New York Univ., New York). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 679-90(Mar. 1963).

The steady flow of a perfectly conducting magnetohydrodynamic fluid past a thin nonconducting airfoil is studied with the usual model in which the fluid variables obey the Lundquist equations linearized about a constant unperturbed flow. Hyperliptic flows, in which hyperbolic and elliptic fields are superimposed, are considered. Results of Grad, McCune and Resler, and Sears and Resler are extended and considered in detail for the case of an arbitrarily inclined unperturbed field. The general solution contains four line singularities along the characteristics through the ends of the body and has two arbitrary constants. By a generalized Kutta-Joukowski condition, these constants are fixed so that two of the line singularities disappear. Specifically, it is required that the solution be locally square integrable. Behavior of the exponents of the singularities is investigated by numerical computation and, in limiting cases, analytically. The singular parts of some flows are investigated numerically. (auth)

20631 A SIMPLE MHD FLOW WITH HALL EFFECT. Richard H. Levy (Avco-Everett Research Lab., Everett, Mass.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 698-9 (Mar. 1963).

A simple magnetohydrodynamic flow is described in which the Hall currents can be calculated exactly and the results compared with those that follow from the usual simplifying assumptions of reducing in fixed ratios the conductivities parallel and perpendicular to the field lines. (C.E.S.)

20632 INSTABILITY OF ARC COLUMNS. J. K. Harvey, P. G. Simpkins, and B. D. Adcock (Imperial Coll. of Science and Tech., London). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 714-16(Mar. 1963).

Tests performed using a Giannini vortex-stabilized arc-heater equipped with a constrictor type of anode are described. Arc chamber pressures range between 0.1 and 1 atm. Measurements were made of the instantaneous arc voltage, current, and the intensity of visible radiation of the plasma after it was expanded to a supersonic velocity. Both argon and nitrogen gases were used. Results indicate that it is possible to have a stable arc column configuration for argon but stable operation was not achieved when running with nitrogen. (C.E.S.)

20633 FOKKER-PLANCK EQUATION. Edward A. Desloge (Florida State Univ., Tallahassee). Am. J. Phys., 31: 237-46(Apr. 1963).

The Fokker-Planck approximation to the interaction term in the Boltzmann transport equation is discussed. For the case of binary collisions a simple derivation of this term is presented. The resultant expressions for the associated quantities (Δv_i) and $(\Delta v_i \Delta v_i)$ are evaluated for the case of a fully ionized gas. Several forms of the distribution function are considered. (auth)

20634 CLASSICAL DISTRIBUTION OF A MUTUALLY INTERACTING SYSTEM OF PARTICLES. Carl A. Barlow, Jr. (Texas Instruments Inc., Dallas). Am. J. Phys., 31: 247-9(Apr. 1963).

It is shown that subject to very general conditions that do not exclude strong or velocity dependent interactions but that tend to restrict consideration to systems having only long range forces, the most probable distribution of an assembly of interacting particles is classically given exactly by a Boltzmann distribution in which appears a term identical to an interaction with the associated most probable self-consistent field. (auth)

20635 ACCEPTABLE SOLUTIONS AND BOUNDARY CONDITIONS FOR THE SCHRÖDINGER AND DIRAC EQUATIONS. Baxter H. Armstrong and Edwin A. Power (Lockheed Missiles and Space Co., Palo Alto, Calif.). Am. J. Phys., 31: 262-8(Apr. 1963).

It is shown that the condition of finiteness at the origin, usually imposed on solutions to the nonrelativistic Schrödinger equation for the hydrogen atom (and some other systems) is not necessary. The quadratically integrable $l = 0$ anomalous solution that is usually excluded in this fashion is not a solution to the Schrödinger equation at the origin, and consequently does not need to be excluded by a boundary or other type condition. The relativistic generalization through the Dirac equation of this anomalous solution is not quadratically integrable. The solution generalized according to the relativistic Schrödinger equation is quadratically integrable and obeys the equation at the origin. Consequently, a boundary or other type condition may still be needed in a general relativistic theory. (auth)

20636 ACCELERATING FRAMES OF REFERENCE AND THE CLOCK PARADOX. Harry Lass (California Inst. of Tech., Pasadena). Am. J. Phys., 31: 274-6(Apr. 1963).

The Lorentz–Einstein transformations are obtained by a method that enables one to derive a coordinate transformation between an inertial frame of reference and a noninertial accelerating system. With the aid of this transformation, one computes the explicit time for the round trip of the noninertial twin who leaves the inertial twin with initial speed $-V$, and returns by means of an acceleration. It is found that the accelerating twin returns younger than the inertial twin. (auth)

20637 SOME APPLICATIONS OF THE BREHME DIAGRAM. Francis W. Sears (Dartmouth Coll., Hanover, N. H,). Am. J. Phys., 31: 269-73(Apr. 1963).

The Lewis–Tolman collision, the Feynman clock, the

relativistic Doppler effect, and the "twin paradox" are analyzed by means of a Brehme diagram. (auth)

20638 REMARKS ON THE BOUND STATES OF A CENTRAL POTENTIAL IN QUANTUM MECHANICS. B. W. Downs (Univ. of Colorado, Boulder). Am. J. Phys., 31: 277-9(Apr. 1963).

A simple proof is given of the fact that the ground state of a central potential is an S state. The ordering of the bound states of a central potential according to the value of the angular momentum and the number of nodes of the solution to the radial Schroedinger equation is also discussed. (auth)

20639 A TWO-BODY PROBLEM OF CLASSICAL ELECTRODYNAMICS: THE ONE-DIMENSIONAL CASE. Rodney D. Driver (Univ. of Wisconsin, Madison). Ann. Phys., 21: 122-42(Jan. 1963). (SCR-586)

The equations of motion for the two-body problem of classical electrodynamics can be formulated by substituting the expressions for the field of a moving charge, calculated from the Lienard-Wiechert potentials, in the Lorentz-Abraham force law. In this paper, radiation reaction is omitted; and the charges are assumed to move along the x-axis. Due to the finite speed of propagation, c, of electrical effects, the differential equations involve time delays that depend upon the unknown trajectories. Thus the equations of motion are not ordinary differential equations, and a unique solution for $t > t_0$ is not determined merely by specifying the positions and velocities of the charges at t_0. Rather arbitrary initial trajectories of the two charges are specified over some appropriate interval $[\alpha,t_0]$ where $\alpha < t_0$. Under suitable conditions the existence of a unique extension of these trajectories that satisfy the equations of motion for all $t > t_0$ unless and until the charges collide can be shown. The solution also depends continuously on the given initial trajectories. It is shown that two point charges of like sign can not collide, while two charges of opposite signs may or may not collide, depending upon the initial data. Moreover, in the event of a collision, the velocities of the two charges become $+c$ and $-c$ at the instant of collision. The effect of an external electric field in the x-direction is also considered. (auth)

20640 A SUBSTITUTION PRINCIPLE FOR STEADY MAGNETOGASDYNAMIC FLOWS. J. N. Kapur (Indian Inst. of Tech., Kanpur, India). Appl. Sci. Res., Sect. B, 9: 444-50(1963).

The substitution principle of Prim for steady flows of ideal gases was extended to the case of steady magnetogasdynamical flows, both with and without dissipative mechanisms. The extended principle can be used both for constructing new solutions from known solutions in magnetogasdynamics as well as for studying rotational flows of conducting gases. (auth)

20641 MAGNETOHYDRODYNAMIC FLOW ALONG WAVY WALLS. L. J. F. Broer and L. Van Wijngaarden (Technische Hogeschool, Delft, Netherlands). Appl. Sci. Res., Sect. B, 9: 451-69(1963).

The two-dimensional steady linearized motion of a conducting fluid past a thin plate of sinusoidal shape is considered. An external magnetic field is applied parallel to the undisturbed flow. Solutions are obtained for the cases where the phase difference between upper and lower size is 0 and π respectively. It is shown that in the latter case the linearization breaks down for an infinitely thin plate. The solution for finite thickness is given. (auth)

20642 REPRESENTATION OF SYMMETRY TRANSFORMATIONS IN QUANTUM MECHANICS. Ulf Uhlhorn (Univ. of Stockholm). Arkiv Fysik, 23: 307-40(1963). (In English)

A generalization of Wigner's representation theorem is presented that may be applied when superselection rules (of a specified character) must be taken into account. At the same time some gaps in existing proofs of Wigner's theorem are eliminated. The connection between Wigner's theorem and the so called fundamental theorem of projective geometry is pointed out, and a new, short proof of the latter theorem (valid for an arbitrary field of numbers) is presented. The equivalent possibilities of characterizing symmetry transformations as mappings leaving invariant the logical structure of quantum mechanics, as isometric linear or conjugated linear transformations connecting two complex Hilbert spaces, or as mappings leaving invariant the algebraic structure of quantum mechanics (or equivalently the structure of the equations of motion) are discussed and lead to an invariant (coordinate free) characterization of reversal of the direction of motion (time inversion). An analogue of Wigner's theorem for symmetry transformations in the recently discussed quaternion quantum mechanics is proved in an appendix, and it is pointed out how quaternion quantum mechanics, as well as ordinary complex quantum mechanics, may be consistently represented in the framework of real quantum mechanics, which in this sense appears as a super theory. The symmetry transformations of classical mechanics are discussed in relation to their quantum mechanical analogues in another appendix. They are intimately connected with the canonical formalism. (auth)

20643 QUANTUM FIELD THEORY WITHOUT OPERATORS. J. Rzewuski (Univ. of Warsaw). Bull. Acad. Polon. Sci., Ser. Sci., Math., Astron. Phys., 11: 31-6(1963). (In English)

A purely functional formulation of the S-matrix theory is presented that avoids the motion of field operators. This eliminates the mathematical difficulties connected with operator methods. (C.E.S.)

20644 THE VISCOSITY OF LIQUID HELIUM II BETWEEN 0.79°K AND THE LAMBDA POINT. A. D. B. Woods and A. C. Hollis Hallett (Univ. of Toronto). Can. J. Phys., 41: 596-609(Apr. 1963).

Values of the viscosity of the normal component of liquid helium II were determined using the rotating cylinder (Couette type) viscometer. Primary attention was given to the temperature range between 0.79 and 1.1°K; values at higher temperatures were determined to provide a check on previous determinations. The results over the whole temperature range are closely fitted by an equation of the form given by Khalatnikov. (auth)

20645 REIGNITION OF FREELY RECOVERING SPARK CHANNELS IN HYDROGEN. R. J. Churchill (Univ. of British Columbia, Vancouver). Can. J. Phys., 41: 610-24(Apr. 1963).

An experimental technique and apparatus for the measurement of spark gap reignition in freely recovering spark channels in hydrogen are described. A unidirectional 235-ka current pulse produces the initial discharge while subsequent reignition is effected by a voltage generator whose output approximates a step-function over 50 μsec. Recovery characteristics are given for 16-mm-diameter tungsten rod electrodes in hydrogen at pressures ranging from 200 to 760 mm Hg, for 4-mm-diameter tungsten rods, and for 16- and 76-mm-diameter copper electrodes at 760 mm Hg. Gap length was varied from 1 to 5 mm. Study of the parameters shows that electrode size has the most pronounced effect on the recovery process. The deionization and re-

covery mechanisms are predicted theoretically and verified during the final recovery period where reignition by spark breakdown is observed. Gas temperatures derived from the recovery results are in good agreement with measured values. (auth)

20646 THE LOSS OF FREE ELECTRONS IN IRRADIATED AIR. B. G. Young, A. W. Johnson, and J. A. Carruthers (Defence Research Chemical Labs., Ottawa). Can. J. Phys., 41: 625-31(Apr. 1963).

The loss of free electrons in air, nitrogen, and oxygen is studied as a function of pressure by continuously irradiating the gases with high-energy electrons and measuring the equilibrium electron densities with a microwave probe. At low pressures (1–10 mm Hg) electrons are lost by free diffusion to the chamber walls before cooling. At intermediate pressures (10–100 mm Hg) electrons cool rapidly without loss to thermal energy and then disappear by three-body attachment in air and oxygen, and by electron-ion recombination in nitrogen. At high pressures (100–1000 mm Hg) the electron density increases with irradiation time and the controlling loss mechanism is uncertain. (auth)

20647 SBORNÍK PRACÍ. II. ČESKOSLOVENSKÉ KONFERENCE O ELEKTRONICE, PRAHA, DUBEN 1962. (The 2nd Czechoslovak Conference on Electronics Transactions, Prague, April 1962). Cesk. Casopis Fys., 12: 397-734t(1962). (In Czech)

Sixty three papers are included; separate abstracts have been prepared for 26. The remaining 37 papers cover such topics as electron and ion optics; materials erosion and spectroscopy in plasma; properties and uses of electron emission; high-vacuum technology; and microwave equipment. (T.F.H.)

20648 ON THE WORK OF THE INSTITUTE OF MAGNETOHYDRODYNAMICS IN JENA. M. Steenbeck (Inst. for Magnetohydrodynamics, German Academy of Science, Jena). Cesk. Casopis Fys., 12: 414-27(Apr. 1962). (In Czech)

Work carried out by the Institute for Magnetohydrodynamics in Jena is described. Problems of an astrophysical character concerning the flow of plasma, considering the turbulence region, through a magnetic field are discussed. The minimum principle and its application to an arc discharge are studied. Results are given of experiments that prove that if the partial pressure of the electrons in a low-pressure discharge reaches the same order of magnitude as the gas pressure, the electrons push out the latter from the middle of the tube and the maximum of light emission is thus brought nearer to the edge of the tube. Other work deals with the normal cathode drop of a glow discharge. Experiments with a fast toroidal discharge are also described. (auth)

20649 THERMIONIC ENERGY CONVERTER. L. N. Dobretsov (Dobrecov) (Inst. of Technical Physics, Leningrad). Cesk. Casopis Fys., 12: 428-38(Apr. 1962). (In Czech)

An interpretation is given of the physical processes in the activity of a thermionic converter. Information is presented on the state of research into practically applicable thermoelectron converters. Two types of converters are mentioned: a vacuum converter with a small distance between the electrodes; and a converter with cesium vapors, the construction of which is technically simpler. Three kinds of working regimes are described for the converter with cesium vapors: Knudsen, diffusion, and plasmatic. These regimes are evaluated from the point of view of suitability for application. In connection with the conversion of nuclear into electrical energy in a thermionic converter, a description is given of an existing converter. (auth)

20650 HOLLOW ELECTRON BEAMS IN A PERIODIC MAGNETIC FIELD. J. Nagy (Inst. for Communications Techniques, Budapest). Cesk. Casopis Fys., 12: 447-50 (Apr. 1962). (In Czech)

The design is studied of hollow electron beams of constant axial potential in a periodic axial magnetic field. The conditions of focusing the beam are given, from which the amplitude and the length of the period of the magnetic field can be obtained in an appropriate form. Use is made of the paraxial approximation. (auth)

20651 THE SHAPE OF ELECTRIC FIELD ALONG A GIVEN ELECTRON TRAJECTORY. E. Podskalský. Cesk Casopis Fys., 12: 459-62(Apr. 1962). (In Czech)

Equations are given that closely describe electron trajectories in progressive stages, and are suitable for use in computers. (auth)

20652 ELECTRIC FIELDS OF BUNCHES OF CHARGED PARTICLES. A. L. Sushkov (Suškov) (Electrotechnical Inst., Leningrad). Cesk. Casopis Fys., 12: 462-8(Apr. 1962). (In Czech)

The static problem of finding the electric field of bunches of charged particles with rotational symmetry when the charge distribution is nonuniform is solved. Formulas are given for the fields of cylindrical, annular, and coaxial bunches in a metal tube. The longitudinal field component of the cylindrical bunch with a nonuniform charge distribution is analyzed in detail, and it is demonstrated that the variation in the longitudinal field component at the boundary and off the bunch can be expressed by an elementary function. (auth)

20653 BUNCHING OF IONS IN AN OMEGATRON. J. Vejvodová (Charles Univ., Prague). Cesk. Casopis Fys., 12: 490-6(Apr. 1962). (In Czech)

On the basis of the theory of the two-dimensional omegatron, it is demonstrated that bunching of resonant ions takes place in the omegatron. The bunching zone rotates with a corresponding cyclotron frequency, which rotation results in rectangular periodic pulsations of the collector current. The nonresonant ions, of masses near the resonant masses, after having left the bunching zone do not strike the collector simultaneously with the resonant ones. This effect improves the natural resolving power of the device. (auth)

20654 THE ELECTRIC RESISTANCE OF PLASMA AS A FUNCTION OF TEMPERATURE AND PRESSURE. J. Brablc. Cesk. Casopis Fys., 12: 509-16(Apr. 1962). (In Czech)

From an analogy with the transfer coefficients, a picture is obtained of the temperature and pressure dependence of the electrical resistance of plasma, determined both graphically and analytically. Conclusions are reached for the diagnostics and homogeneity of plasma in three of the four regions found. The results are extrapolated to the nuclear plasma. (auth)

20655 COLLECTIVE CORRELATION OF PLASMA. C. M. Tchen (National Bureau of Standards, Washington, D. C.). Cesk. Casopis Fys., 12: 516-21(Apr. 1962). (In Czech)

The one-particle distribution function is described by the BBGKY (Born-Bogoliubov-Green-Kirkwood-Yvon) equation, while the correlation function is determined by an equation of the Vlasov type (with self-consistent field, but without

collision). Oscillations of small amplitudes are considered. The dispersion relation is obtained, and the Landau damping is calculated. (auth)

20656 ON THE INFLUENCE OF THE STEPWISE IONIZATION IN THE POSITIVE COLUMN OF THE LOW PRESSURE DISCHARGE. A. Rutscher. Cesk. Casopis Fys., 12: 521-9(Apr. 1962). (In Czech)

Measurements of electron temperature in neon indicate that, particularly in the higher current region and using smaller relative diameters of tubes, values of temperatures are found that are remarkably lower than the values effected by simple diffusion theory assuming direct ionization. When the final concentration of charged particles upon the wall of the tube is considered, as well as the dependence of ion mobility on field strength, the temperatures obtained are too high. Using the conditions of stepwise ionization, an attempt is made to take quantitatively into account the influence of metastable atoms on the parameters of a single plasma column. (auth)

20657 ESTIMATION OF UPPER THERMAL LOAD LIMIT FOR ROTATING WATER-COOLED METAL ELECTRODES FOR PLASMA TORCHES. B. Grycz (Charles Univ., Prague). Cesk. Casopis Fys., 12: 530-5(Apr. 1962). (In Czech)

An analysis of the function of the rotating electrode in a plasma torch is made. Such an electrode works as an element providing a suitable contact in both electrical and thermal circuits of the plasma-torch device. Since the temperature of the outer surface of the electrode is first among the influences causing the material losses, a few approximations are used to estimate the temperature field of this surface. The resulting temperature field is considered to be a superposition of the steady-state field (determined by the total heat flow, the thermal resistance of the material of the electrode, and the thermal resistance of the metal-liquid boundary) and of the variable temperature field created by the "rain" of the anode or cathode spots. (auth)

20658 SPUTTERING OF IRON, GRAPHITE, AND MOLYBDENUM BY Hg-IONS. J. Kramář. Cesk. Casopis Fys., 12: 539-43(Apr. 1962). (In Czech)

Sputtering of metals at 100 to 2000 v is studied. Pressures of 10^{-5} Torr are used. Iron, molybdenum, and graphite are studied, and main emphasis given to low potentials. (auth)

20659 THE INFLUENCE OF THE PRESENCE OF SOME GASES ON THE ELECTROCHEMICAL SPUTTERING OF GRAPHITE IN THE LOW-PRESSURE DISCHARGE IN THE MERCURY VAPOR. S. Láska and F. Cibulka. Cesk. Casopis Fys., 12: 543-5(Apr. 1962). (In Czech)

The formation of impurities in a mercury valve is supposed not to be caused by the sputtering of graphite, but by chemical and electrochemical reactions in which both the graphite of the main anode and mercury vapors take part. The presence of oxygen causes decrease of weight of graphite electrodes, and nitrogen causes deposition of impurities. (auth)

20660 ANALOGY BETWEEN WAVE OF STRATIFICATION IN PLASMA AND WAVES ON FLUID SURFACE. L. Pekárek and V. Krejčí (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 12: 546-52(Apr. 1962). (In Czech)

Moving striations in a positive column discharge plasma differ significantly from most other wave phenomena in continuous media. The particular properties of this phenomenon are evident in the wave of stratification, in which the striations are produced by an aperiodic pulse disturbance. The properties of the wave of stratification and of the striations produced by an oscillation disturbance are described in detail and compared with the properties of gravitational and capillary waves on a fluid surface. Both types of phenomena are compared from the point of view of the physical character of the processes participating in them. (auth)

20661 STANDING STRIATIONS IN HYDROGEN AND DEUTERIUM. Oto Štirand (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 12: 552-4(Apr. 1962). (In Czech)

The reason for the existence of standing striations in hydrogen and deuterium is not known. It is determined that hydrogen has more of a tendency to form this phenomenon than deuterium. (auth)

20662 THE GROUP AND PHASE VELOCITY OF STRIATIONS AT HIGH CURRENTS. T. Růžička (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 12: 554-6(Apr. 1962). (In Czech)

Mathematically calculated values are compared to experimental results. Neon and argon comply with the known formulas and equations, while krypton and helium show irregularity. Striations are conjectured to behave as waves of an ionic level. (auth)

20663 CYCLOTRON RESONANCE OF ELECTRONS IN ELECTRIC DISCHARGES IN He AND Ar. J. Ďurček. Cesk. Casopis Fys., 12: 557-60(Apr. 1962). (In Czech)

Discharges at pressures of 10^{-1} to 10 mm Hg and in electric currents of 10 to 200 μa are studied. The influence of pressure is much stronger than that of current. (auth)

20664 CONTRIBUTIONS TO EMISSION MICROSCOPY. E. Guyenot and E.-A. Soa. Cesk. Casopis Fys., 12: 608-10(Apr. 1962). (In Czech)

Layers of barium, strontium, and cesium oxides on tantalum, tungsten, and molybdenum were studied. The emission pattern was described. (auth)

20665 A NEW PHOTO-MULTIPLIER WITH A SMALL TIME-OF-FLIGHT DISPERSION. P. Goerlich, A. Krohs, and H.-J. Pohl. Cesk. Casopis Fys., 12: 623-8(Apr. 1962). (In Czech)

A photomultiplier intended for measurements in the nsec region is developed, and is a continuation in the series of multipliers for scintillation measurements. Some of the details in the design of a dynode system, and the results obtained, are described. In a meandering system of electrodes high values of the electric field strength and dynode current are obtained, and thus the dispersion of the transit times and the space changes is lowered. The starting time is about 2 nsec, the decay time 3 nsec, and the mean width approximately 3 nsec. The linearity of the impulses is preserved up to a current of 0.5 amp. Impulses having a current up to 1.5 amp in a photomultiplier-stilbene connection are obtained for gamma radiation of 800 kev. (auth)

20666 MEASUREMENT OF EXTREMELY SHORT DECAY TIMES OF ORGANIC PHOSPHORS. H. G. Kloss. Cesk. Casopis Fys., 12: 628-33(Apr. 1962). (In Czech)

A description is given of a fluorometer that works with an accuracy of 2×10^{-11} sec. A modulated electron ray is used in it to excite the luminophore, and the phase difference between the excitation and the emission of light is measured by electronic means. The solution of the practical difficulties that arise is described, and the factors that must be respected in measuring such short time intervals with accuracy are dealt with. (auth)

20667 ION PUMP WITH TITANIUM-GETTER EFFECT. A. O. Comsa and C. Simionescu (Inst. of Atomic Physics, Bucharest). Cesk. Casopis Fys., 12: 644-5(Apr. 1962). (In Czech)

The construction is described of a vacuum pump. It is easy to make and can be assembled and disassembled. It is similar to the "Vacion" pump. (auth)

20668 ION PUMP WITH MAGNETIC FIELD. C. Kiliszek and W. Czarycki (Industrial Inst. of Electronics, Warsaw). Cesk. Casopis Fys., 12: 646-7(Apr. 1962). (In Czech)

A vacuum pump is constructed with a double anode, having a capacity of 1.5 liters/sec with an anodic potential of 5 kv and a magnetic field intensity of 1500 gauss. A pressure of 2×10^{-10} mm Hg is obtained. (auth)

20669 METHOD AND APPARATUS OF IMPULSE MASS SPECTROMETER FOR STUDYING FAST PHENOMENA IN LOW-PRESSURE GASES AND NON-STATIONARY PLASMA. V. A. Simonov and A. G. Mileškin. Cesk. Casopis Fys., 12: 653-65(Apr. 1962). (In Czech)

The characteristics of an impulse point spectrometer (so-called chronotron), intended for the analysis of neutral gas in a pressure range of 1×10^{-10} to 10 mm Hg, are given for the analysis of ions in a non-stationary plasma with a concentration of 1×10^{6} to 1×10^{16} cm^{-3} and for the analysis of ions in a strong magnetic field. The duration of the processes studied may be from 1×10^{-7} sec up to continuous operation. The extent to which the method can be used is shown on examples of the analysis of currents of molecules desorbed from the surfaces of solids, a study of the mechanism of sorption and catalytic reactions on renewed surfaces using stable isotopes, a study of the interaction of hydrogen plasma with the walls of vacuum systems, a study of the laws of the plasma in impulse discharges, and a study of the passage of atomic bonds through highly ionized plasma. (auth)

20670 SPUTTERING OF RADIOACTIVE ATOMS FROM SURFACE-LAYERS OF SINGLE CRYSTALS BY IONIC BOMBARDMENT. Č. Jech (Inst. of Physical Chemistry, Czechoslovak Academy of Sciences, Prague). Cesk. Casopis Fys., 12: 669-72(Apr. 1962). (In Czech)

Pb^{214} and Bi^{214} are incorporated into the surface layers of lead and copper single crystals and then sputtered by bombarding with a beam of krypton ions. The directional distribution of the material of the sputtered single crystal is compared with the distribution of the sputtered activity. In the lead single crystals the two distributions are substantially the same, which result permits the use of radioactive labelling in this way for studying the crystal structure of very thin layers on the surface of a lead single crystal. (auth)

20671 THE RESONANCE PROPERTIES AND FLUCTUATIONS DUE TO HIGH-FREQUENCY OSCILLATIONS AMPLIFICATION IN THE SYSTEM PLASMA-ELECTRON BEAM. G. A. Bernashevskii (Bernaševskij) and Z. S. Chernov (Černov) (Inst. of Radiotechnology and Electronics, Academy of Sciences, Moscow). Cesk. Casopis Fys., 12: 686-90(Apr. 1962). (In Czech)

A study is made of the resonance and fluctuation properties of a plasma-electron beam system in a longitudinal magnetic field. It is found that in the experiment the resonance properties appear far less sharply than in theory. The hypothesis is made that the fluctuations in the electron beam are decisive for the height of the noise level in the system and that the fluctuations of the plasma itself have only a small influence. (auth)

20672 KINETICS OF ELECTRON MOTION IN A PHASOCHRONOUS GENERATOR WITH COMBINED INTERACTION. I. V. Akalovskii (Akalovskij). Cesk. Casopis Fys., 12: 691-7(Apr. 1962). (In Czech)

The principle of the phasochronous generator with transversal and combined interaction is described. Relations are given for the magnetic induction of the generator of a direct and back wave and equations are found for the trajectories of the electrons in a generator with combined interaction. (auth)

20673 CONTRIBUTIONS TO THE PROBLEM OF THE ELECTRON. E. Winter. Cesk. Casopis Fys., 12: 728-30 (Apr. 1962). (In Czech)

The following problems are considered: the minimum magnitude of the basic physical quantities; calculation of Planck's action quantum and elementary charge from the minimum quantities; the introduction of the shortest possible trajectory; calculation of the electron mass from the field energy, in order to give the correct value of the electron radius; and discontinuous motion of the electron. It is shown that the assumption of discontinuous motion of an electron permits the wave process, which is closely connected with the displacing current of the moving electron, to be ascribed to the moving electron. The wavelength of this process is given by the relation $\lambda = (d/v)c$, where d is the minimum trajectory, v the velocity of the electron and c the velocity of light. The identification of this wavelength with De Broglie's wavelength of an electron gives for d the Compton electron wavelength $d = h/mc$. (auth)

20674 RESOLUTION OF THE FOKKER-PLANCK EQUATION USING CAMPBELL THEOREMS. Augustin Blaquière (Faculte des Sciences, Paris). Compt. Rend., 256: 1084-6(Jan. 28, 1963). (In French)

The equivalence of two methods for the study of aleatory physical systems was previously verified (CEA-2115). One deduces the equation that controls the associated generating function of probabilities (equivalent to the Fokker-Planck equation of the system), and the other depends on the use of Campbell theorems. This permits obtaining simply the solution of the Fokker-Planck equation on which the system depends. (tr-auth)

20675 DISTRIBUTION OF $\underline{N}$ PARTICLES BETWEEN $\underline{g}$ CELLS. LAW OF FLUCTUATIONS. Bernard Decomps and Alfred Kastler (Université, Paris). Compt. Rend., 256: 1087-9(Jan. 28, 1963). (In French)

The general distribution and fluctuation formulas are established for $\underline{N}$ particles distributed at statistical equilibrium among $\underline{g}$ cells of the phase space. The calculation is made for classical particles obeying Maxwell-Boltzmann statistics and for particles obeying Bose-Einstein statistics. The formulas generalize the well-known formulas that are valid only when $\underline{g}$ is large. (tr-auth)

20676 DRYING SPEED OF A NUCLEAR EMULSION ROLLED ON GLASS SUPPORT AND IONIZATION PARAMETERS AT HIGH ENERGIES. René Brou, Jacques Bermond, and Claudette Patou (Université, Caen, France). Compt. Rend., 256: 1966-9(Feb. 25, 1963). (In French)

The parameters connected with the structure of the trajectory left by a particle in an ionographic emulsion depend on numerous factors relative to the emulsion and to the treatment it receives. The effect of the drying speed of an Ilford G_5 emulsion after rolling on a glass support on the parameters, mean length of gaps, total length of gaps, density of identical gaps, and mean length of grain accumulations, were studied. (J.S.R.)

20677 PRESSURE-DENSITY-TEMPERATURE RELATIONS OF FREEZING LIQUID PARAHYDROGEN TO 350

ATMOSPHERES. R. D. Goodwin and H. M. Roder (National Bureau of Standards, Boulder, Colo.). Cryogenics, 3: 12-15(Mar. 1963).

Three new melting pressures for parahydrogen are utilized in an empirical, melting-line representation to obtain a provisional set of densities for liquid parahydrogen in equilibrium with solid parahydrogen. (C.E.S.)

20678 THE ORTHOBARIC DENSITIES OF PARAHYDROGEN, DERIVED HEATS OF VAPORIZATION, AND CRITICAL CONSTANTS. H. M. Roder, D. E. Diller, L. A. Weber, and R. D. Goodwin (National Bureau of Standards, Boulder, Colo.). Cryogenics, 3: 16-22(Mar. 1963).

Closely spaced experimental data are presented and used for defining a consistent set of values for critical constants that describe the two-phase boundaries between saturated liquid and saturated vapor. The heat of vaporization is derived. The various considerations affecting the selection of the critical temperatures are discussed. (C.E.S.)

20679 FILM BOILING IN LIQUID HELIUM. P. C. Eastman and W. R. Datars (Defence Research Telecommunications Establishment, Ottawa). Cryogenics, 3: 40-1(Mar. 1963).

Thermal effects that may accompany the onset of film boiling in liquid helium are discussed. (C.E.S.)

20680 ON THE GROWTH AND DECAY CURVES OF THE LUMINESCENCE OF SOME OXYGEN DOMINATING LUMINOUS MATERIALS. H. Witzmann, H. Anderson, and K. Oertel. Czech. J. Phys., 13: 94-8(1963). (In German)

The influence of temperature and traces of elements on the form of the function describing the growth and decay of luminescence was studied on a series of strontium-boron phosphors. With both effects the monomolecular character of kinetics was found both for excitation and for emission. The experimental results permit conclusions to be reached as to the sensitization. (auth)

20681 METHODS FOR DIRECT CONVERSION OF NUCLEAR FUSION ENERGY INTO ELECTRICAL ENERGY. K. Meyer. Energietechnik, 12: 496-503(Nov. 1962). (In German)

A review of methods that according to the present state of knowledge have prospects, in combination with nuclear reactors, for direct production of electric energy is presented. These methods depend on the principles of thermoelectronic, thermoelectric, and magnetohydrodynamic generators as well as fuel cells. The chief mode of action of conceivable instruments based on these methods is explained, the state of research is explained by examples from the literature, and the prospects for application are discussed. (tr-auth)

20682 ON THE TEMPERATURE OF THE SPARK FOR BREAKDOWN OF SOLID DIELECTRICS. V. I. Obukhov and A. I. Licitsyn. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 1, 66-72(Jan. 1963). (In Russian)

An approximate calculation of the temperature and certain characteristics of the final stage of disruption of a model solid dielectric, monocrystals of rock salt is given. The calculation is made on the assumption that the substance in the channel is in a state of neutral charged plasma and is based on a consideration of the balance of energy in the process of channel widening. From results of calculations it is seen that when the discharge first develops, temperature increases and reaches its maximum value. Later it again decreases due to the fact that the widening of the channel proceeds more rapidly than the energy inflow. As the average disruption gradient increases and the inductivity of the discharge circuit decreases, maximum temperature increases. This process continues until the rate of radiant heat production equals the rate of energy release in the discharge channel, which sets the limit for further temperature increase. (auth)

20683 ON THE POSSIBILITY OF INTERFEROMETRIC INVESTIGATION OF GASEOUS HETEROGENEITY WITH INTERMITTENT DENSITY DISTRIBUTION. V. A. Emel'yanov. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 1, 79-86(Jan. 1963). (In Russian)

The effect of shock waves and large density gradients on the accuracy of interferometric density determination in axisymmetric supersonic flows is considered. The results may be used to experimentally investigate density distribution behind shock waves, in the base region behind the model, and in the boundary layer. (auth)

20684 THE CONSTANT-MACH-NUMBER MHD GENERATOR. D. T. Swift-Hook and J. K. Wright (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). J. Fluid Mechan., 15: 97-110(Jan. 1963).

The optimum duct design in a magnetohydrodynamic generator is shown to be close to the one in which the flow Mach number remains constant. This constant-Mach-number generator is analyzed in some detail, and it is shown that the optimum Mach number can be defined to within a few percent. For a γ of 1.25, this optimum is near 0.85. For very short ducts, the maximum power output is obtained near matched-load conditions but for rather longer ones maximum total power output is obtained by working as close to short-circuit conditions as is practicable. Against this, the minimum compressor requirements are found by working as close to open-circuit conditions as is practicable, and so a compromise must be reached for optimum overall generator design as far as load conditions are concerned. This will probably give an internal ohmic loss in the fluid of about one-third of the total output. Curves are presented which enable the optimum Mach number to be determined with greater precision when the optimum load conditions have been selected. (auth)

20685 STRUCTURE OF THE THREE-PARTICLE SCATTERING OPERATOR IN CLASSICAL GASES. P. Résibois (Université Libre, Brussels). J. Math. Phys. (N. Y.), 4: 166-73(Feb. 1963).

It is shown that in all cases where the finite duration of the collision may be neglected, there is a complete equivalence between the 3-particle scattering operator obtained by Prigogine and his co-workers and the corresponding expression derived by Choh and Uhlenbeck using Bogolubov's method. Great emphasis is put on the irreducible character of the three-body collision. Only situations in which the three particles are simultaneously interacting play a role in both theories. (auth)

20686 STOCHASTIC LIOUVILLE EQUATIONS. Ryogo Kubo (Tokyo Univ.). J. Math. Phys. (N. Y.), 4: 174-83(Feb. 1963).

When a dynamical system has a perturbation that is considered as a stochastic process, the Liouville equation for the system in the phase space or the space of quantum-mechanical density operators is a sort of stochastic equation. The ensemble average of its formal integral defines the relaxation operator $\Phi(t)$ of the system. By the definition $\Phi(t) = \exp K(t)$, the cumulant function $K(t)$ may be introduced. Some general properties are first discussed for a simple example of an oscillator with random frequency modulation and then, concepts of slow and fast modulation are considered. These concepts can be generalized to more general types of stochastic Liouville equations. It

is shown that by various possibilities of defining generalized exponential functions, this approach may be useful to understand some essential features of the problem from an unified point of view. (auth)

20687 ON THE KINETIC THEORY OF DENSE GASES. E. G. D. Cohen (Universiteit, Amsterdam). J. Math. Phys. (N. Y.), 4: 183-9(Feb. 1963).

A statistical mechanical theory of a dense gas that is not in equilibrium is presented, that is completely analogous to the well known theory of a dense gas in equilibrium. In particular, an expansion of the pair distribution function in powers of the density for a gas not in equilibrium is given, corresponding with that in equilibrium to all orders in the density, that can be represented by the same diagrams. The expansion can be reduced to that derived by Bogolubov, Uhlenbeck, and Choh from a solution of the B–B–G–K–Y hierarchy. The conditions for the validity of the expansion are, for an infinite system at not too high density, and after the lapse of some time after t = 0: a statistical assumption at t = 0; some conditions on the interaction potential; coarse-grained distribution functions. A simple generalization of the Boltzmann equation to general order in the density is included. Also, the connection with a master equation for a spatially homogeneous system is discussed. (auth)

20688 HYDRODYNAMICS OF A SUPERFLUID CONDENSATE. Eugene P. Gross (Brandeis Univ., Waltham, Mass.). J. Math. Phys. (N. Y.), 4: 195-207(Feb. 1963).

The theory of the condensate of a weakly interacting Bose gas is developed. The condensate is described by a wavefunction normalized to the number of particles. It obeys a nonlinear self-consistent field equation. The solution in the presence of a rigid wall with the boundary condition of vanishing wavefunction involves a de Broglie length. This length depends on the mean potential energy per particle. The self-consistent field term keeps the density uniform except in localized spatial regions. In the hydrodynamical version, a key role is played by the quantum potential. A theory of quantized vortices and of general potential flows follows immediately. In contrast to classical hydrodynamics, the cores of vortices are completely determined by the de Broglie length and all energies are finite. Nonstationary disturbances of the condensate correspond to phonons, rotons, vortex waves etc. They can exchange momentum with rigid boundaries. This is compatible with the vanishing of the wavefunction at a boundary. This condition fully determines the dynamics of the system. These points are illustrated by considering the motion of a foreign ion in a Bose gas, a rotating container of fluid, and the Landau criterion for superfluidity. (auth)

20689 A MICROSCOPIC APPROACH TO SUPERFLUIDITY AND SUPERCONDUCTIVITY. Paul C. Martin (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 4: 208-15(Feb. 1963).

Properties of interacting Bose gases and superconductors are presented. Attempts to derive from fundamental principles, several aspects of the macroscopic two-fluid model of London, Landau, and Tisza, the Landau phonon spectrum for bosons, and the structured condensate envisaged by Onsager and Feynman are discussed. New results were obtained concerning: methods for calculating properties of large, but not necessarily infinite, condensed systems at finite temperatures; methods for performing calculations in boson systems consistent with current conservation and sum rules; results obtained by these methods for the phonon spectrum; more accurate results for the less physical single-particle spectrum at finite temperatures; results obtained for the macroscopically structured condensate in rotating systems that agree with the macroscopically inferred results in Feynman and Onsager; results that treat depletion of the condensate as a result of interaction consistently and verify that the superfluid density, as operationally determined, is not correspondingly depleted; methods in which the entropy plays a central role, for casting the macroscopic theory in a form that lays stress on the renormalized excitations of renormalized interactions; the almost identical features of the mathematics for condensed Fermi and Bose systems; a restatement, in this microscopic transcription, of the Feynman-Onsager argument for flux and vorticity quantization. (auth)

20690 ASYMPTOTIC BEHAVIOR OF THE RADIAL DISTRIBUTION FUNCTION. J. L. Lebowitz (Yeshiva Univ., New York) and J. K. Percus. J. Math. Phys. (N. Y.), 4: 248-54(Feb. 1963).

The pair distribution function in a uniform classical fluid is equivalent to the one-body density when one particle is fixed. An implicit relation for this nonuniform density is found by a functional expansion of the difference of chemical potential and external potential about its value for a system of uniform density. A linearization of this expansion, followed by retention of, at most, second derivatives of the inhomogeneity, reproduces the Ornstein-Zernicke relations for the asymptotic pair correlation. Linearization alone calls for the sum of internal potential and direct correlation function to vanish asymptotically. This relation is developed for the case of weak long-range forces, resulting in the Debye-Hückel expression for an electron gas, and reproducing the asymptotic correlations of the Kac-Uhlenbeck-Hemmer one-dimensional model. The relation is also shown to follow from the virial expansion for the direct correlation function. (auth)

20691 VARIATIONAL STATISTICAL MECHANICS IN TERMS OF "OBSERVABLES" FOR NORMAL AND SUPERFLUID SYSTEMS. C. De Dominicis (Centre d'Études Nucléaires, Saclay, France). J. Math. Phys. (N. Y.), 4: 255-65(Feb. 1963).

Thermodynamical functions are expressed by perturbation theory as stationary functionals of the 1- and 2-body potentials; the stationary conditions yield the 1- and 2-body correlation functions in terms of the potentials. Through the use of diagrammatic methods, it is possible to explicitly invert these relations and express the potentials in terms of the correlation functions; in turn the thermodynamical functions become stationary functionals of the correlation functions. This procedure is carried out for normal (quantum and classical) systems. For superfluid systems, $\frac{1}{2}$, $\frac{3}{2}$-body potentials, and correlation functions need also be considered and the above procedure becomes imperative to eliminate the nonphysical $\frac{1}{2}$, $\frac{3}{2}$-body potentials. The first two steps of the procedure are illustrated, and various features of this formulation and its usefulness are discussed. (auth)

20692 THE MASTER EQUATION WITH SPECIAL TRANSITION PROBABILITIES. E. Verboven (Studiecentrum voor Kernenergie, Mol, Belg.). J. Math. Phys. (N. Y.), 4: 266-70(Feb. 1963).

The Van Hove master equation to general order is solved, making a special ansatz for the function $W_{11'}(kk')$. Approximate solutions are found for strong and weak coupling. For $\lambda = 1$, a comparison is given with the exact numerical solution. (auth)

20693 ASYMPTOTIC FORM OF THE STRUCTURE FUNCTION FOR REAL SYSTEMS. P. Mazur and J. van

der Linden (Universiteit, Leiden). J. Math. Phys. (N. Y.), 4: 271-7(Feb. 1963).

It is shown that the asymptotic formula for the structure function obtained by Khinchin for the case of a system of n noninteracting components, also holds for a classical system of N interacting particles. It is essential for the derivation that the interactions be such that the system behaves in the limit as N tends to infinity, as a thermodynamic system. (auth)

20694 TIME-DEPENDENT STATISTICS OF THE ISING MODEL. Roy J. Glauber (Harvard Univ., Cambridge, Mass.). J. Math. Phys. (N. Y.), 4: 294-307(Feb. 1963).

The individual spins of the Ising model are assumed to interact with an external agency (e.g., a heat reservoir) that causes them to change their states randomly with time. Coupling between the spins is introduced through the assumption that the transition probabilities for any one spin depend on the values of the neighboring spins. This dependence is determined, in part, by the detailed balancing condition obeyed by the equilibrium state of the model. The Markoff process that describes the spin functions is analyzed in detail for the case of a closed N-member chain. The expectation values of the individual spins and of the products of pairs of spins, each of the pair evaluated at a different time, are found explicitly. The influence of a uniform, time-varying magnetic field upon the model is discussed, and the frequency-dependent magnetic susceptibility is found in the weak-field limit. Some fluctuation-dissipation theorems are derived that relate the susceptibility to the Fourier transform of the time-dependent correlation function of the magnetization at equilibrium. (auth)

20695 PROCESS OF FORMATION OF MOLECULAR NITROGEN IONS IN PRESENCE OF HELIUM. L. Herman, P. Felenbok, and R. Herman. J. Phys. Radium, 23: 979-85 (Dec. 1962). (In French)

The population distribution of the molecules in the vibration levels of the initial electronic state for the first negative system of N_2^+ emitted in the afterglow of a helium-nitrogen mixture, is measured by photography. This distribution was compared with that obtained by collision between metastable xenon atoms with normal CO molecules giving excited neutral CO molecules. The excitation selectivity (resonance) is much stronger when the excitation is produced without ionization. The different possible excitation mechanisms are discussed in some detail. (auth)

20696 THEORETICAL ANALYSIS OF TRANSIENT TOWNSEND DISCHARGE OF NON-UNIFORMLY LATERAL DISTRIBUTION. Yasunori Miyoshi (Nagoya Inst. of Tech., Japan), Makota Hayashi, and Tameyoshi Mori. J. Phys. Soc. Japan, 18: 396-408(Mar. 1963). (In English)

Transient Townsend discharge in parallel plane electrodes is restricted by the wall at low pressure, but it has a discharge path narrower than the electrode area at high pressure. The buildup of the transient Townsend discharge of non-uniformly lateral distribution due to electronic and ionic diffusion is described. The general solutions for the electronic and positive-ionic charge distributions are given and the characteristic constants, by which wall effects on the buildup of the discharge can be estimated, are decided. (auth)

20697 AN INEXPENSIVE, HIGH FLASH-POINT, LOW TOXICITY LIQUID SCINTILLATOR OF HIGH EFFICIENCY. R. B. Wilson, P. D. Cross, and B. W. Soole (Royal Naval Scientific Service, Teddington, Middx., Eng.). J. Sci. Instr., 40: 127-8(Mar. 1963).

Studies were made of commercially available aromatic hydrocarbon solvents with high transparencies and flash points for use as scintillator solvents. The most suitable was found to be technical grade Shellsol A, consisting almost entirely (98.3%) of alkylbenzenes (predominantly the triethyl benzenes). The remaining paraffins (1.1%), olefins (0.3%) and naphthenic compounds (0.3%) apparently had no deleterious effects. This solvent had a scintillation efficiency about 95% that of toluene, and for the more energetic radiation there was a suggestion that it becomes slightly more efficient. (M.C.G.)

20698 INVESTIGATION OF THE FIELDS OF QUADRUPOLE LENSES OF CIRCULAR-CYLINDER POLE. Ede Koltay and Ildikó Fejér. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 177-82(Dec. 1962). (In Hungarian)

Measurements were carried out in an electrolyte tank on the optimum radius values of circular cylinders approaching the hyperbolic cylinder-poles of ideal quadrupole lenses. Related to the lens aperture, the optimum R/a ratio was found to be different with the straights subtending various angles with the asymptote. The best coincidence between the ideal and the actual field distribution was found at a ratio of R/a = 1.15. From the data it is possible to calculate for a given R/a the average deviation to be expected in various directions. Measurements carried out by means of a moving coil magnetic flux meter in the field of a quadrupole magnet of R/a = 1.115 radius ratio indicated that the deviation from the ideal field distribution would not exceed the expected value of 2.7%. (auth)

20699 CONSTANT ENERGY DIFFERENCES IN ATOMIC STRUCTURE. Harriman H. Dash (Nassau Hospital, Mineola, N. Y.). Nature, 198: 25-6(Apr. 6, 1963).

Constant second-order energy differences for the hydrogen isoelectronic series, as obtained from optical spectra, were examined. A distinct pattern consistent with the quantum shell structure of the Periodic Table of elements was revealed. The relationship between periodicity and atomic structure is discussed. (C.H.)

20700 ISOBARIC SPIN ALGEBRA. H. Froehlich (Univ. of Liverpool) and Ch. Terreaux. Nucl. Phys., 42: 21-6(Apr. 1963). (In English)

The algebra based on 3 generating elements satisfying the Kemmer-Duffin-Petiau relations, and its 4 irreducible representations are investigated following a previous treatment. These representations are found to be equivalent with those selected from the 4-dimensional rotation group in the 4-dimensional formulation of isospin formalisms. It is shown that the elements of the centrum of the algebra are of basic importance because they permit separation of the various representations without the introduction of operators not contained in the algebra. A compact and completely algebraic description of isospin operators is thus obtained. (auth)

20701 INERTIAL ROTATION IN A WEAK GRAVITATIONAL FIELD. N. L. Balasz (New York State Univ., Oyster Bay, N. Y.) and B. Bertotti. Nuovo Cimento (10), 27: 1087-93(Mar. 1, 1963). (In English)

A direction carried along rectilinearly by a freely falling object may undergo a slight rotation with respect to an inertial frame of reference at infinity when crossing a region of weak gravitational field. To understand a striking paradox arising in the discussion of this problem, a general method is given to compute the amount of rotation between two points lying on the path. It is found that the total rotation depends on a topological property of the path: if two points can be connected by a curve C that lies entirely in

a gravitation-free region, the total rotation is proportional to the flux of the solenoidal part of the matter current through a surface bounded by the path and the curve C. (auth)

20702 THE PAULI EXCLUSION PRINCIPLE FROM A SELF-CONSISTENT FIELD-THEORY OF QUANTUM ELECTRODYNAMICS. M. Sachs (Boston Univ.). Nuovo Cimento (10), 27: 1138-50(Mar. 1, 1963). (In English)

The derivation of a property of the nonlinear field equations of a theory of quantum electrodynamics, which indicates all of the physical consequences of the Pauli exclusion principle for a two-particle system, is extended to the case where there are any number of like (spin one-half) particles in the system. The result follows exactly from a nonlinear and purely field-theoretical approach to the description of the n-particle system, that is based on the two fundamental postulates that require: invariance under the transformations of the proper, inhomogeneous, Lorentz group; and that the interaction between particles rather than the free-particle fields be taken as the elementary entity. The result obtained is extended to the nonrelativistic limit of noninteracting particles where the interaction field of the theory is shown to reduce to the antisymmetrized wave function for the n-particle system of the Schrödinger theory. (auth)

20703 SOME CONSEQUENCES OF "MINIMAL" ANALYTICITY AND UNITARITY IN FIELD THEORY. R. Acharya (Northeastern Univ., Boston). Nuovo Cimento (10), 27: 1151-5(Mar. 1, 1963). (In English)

A proof of the incompatibility of a field theory having a finite number of processes with the principles of unitarity, minimal analyticity, and positive definiteness is presented. It is further argued that such a theory also violates local commutation relations. (auth)

20704 GRAVITATIONAL NEWS. T. A. Morgan and A. Peres (Syracuse Univ., N. Y.). Nuovo Cimento (10), 27: 1266-8(Mar. 1, 1963). (In English)

A study is made of the extent to which the gravitational radiation from a material system can be used to determine the physical properties of the system. The Riemann tensor is used to derive a "news function," and the asymptotic properties of this news function are discussed. The rate at which mass leaves a system as a result of gravitational radiation is calculated. (T.F.H.)

20705 THE RADIATION OF AN ATOMIC ELECTRON IN AN ALTERNATING MAGNETIC FIELD. O. Ya. Savchenko. Opt. Spectry. (USSR). (English Transl.), 14: 1-2 (Jan. 1963).

The wave functions are found for an electron moving simultaneously in the radial field of an atom and an alternating magnetic field. Using the wave functions obtained, the spontaneous radiation emitted by such an electron is calculated. (auth)

20706 A SIMPLE METHOD OF CALCULATING ČERENKOV LOSSES IN A TRANSPARENT UNIAXIAL CRYSTAL. A. B. Kukanov. Opt. Spectry. (USSR) (English Transl.), 14: 62-4(Jan. 1963).

A simple method of calculating the energy losses resulting from Vavilov-Cherenkov radiation in a transparent uniaxial ferroelectric is proposed. Formulas are obtained that permit a determination of the losses by a point charge and an analysis of the conditions necessary for the production of this radiation. (auth)

20707 ON THE POSSIBILITY OF OBSERVING A BOSE-EINSTEIN CONDENSATION OF EXCITONS IN CdS AND CdSe. R. C. Casella (International Business Machines Corp., Yorktown Heights, N. Y.). Phys. Chem. Solids, 24: 19-26(Jan. 1963). (In English)

It is shown that ideally a Bose-Einstein condensation of excitons ought to be observable in CdSe as a narrowing of the fundamental emission line with increasing concentration above a critical concentration, $\sim 10^{16}/cm^3$, using available pulsed light sources. It is concluded (with less justification) that the effect ought also to be observable in CdS. Deviations from ideality and their expected effects on conditions required for observation of the condensation and on its existence are discussed. (auth)

20708 THE BOMBARDMENT OF GOLD FILMS BY INERT GAS IONS. G. J. Ogilvie, J. V. Sanders, and A. A. Thomson (Univ. of Melbourne). Phys. Chem. Solids, 24: 247-59(Feb. 1963). (In English)

Films of gold were bombarded by nearly mono-energetic ions of helium, neon, argon, or xenon in the energy range 15 to 250 ev, and then examined in an electron microscope. The damage caused by the bombardment is found to depend markedly on the energy of the ions and the gas, and to a lesser extent on the orientation of the crystal and the ion flux density. There is a threshold energy for the ions below which no damage is detectable, and its values for neon, argon, and xenon but not helium, are consistent with a model in which a simple collision at the surface may create an interstitial gold atom below the surface. The annealing characteristics depend upon the gas producing the damage. Sputtering yields were measured; at low energies argon sputters {110} surfaces more rapidly than {111}. (auth)

20709 THE CONDUCTION BAND OF CERIUM SULFIDE $Ce_{3-x}S_4$. M. Cutler, R. L. Fitzpatrick, and J. F. Leavy (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Phys. Chem. Solids, 24: 319-27(Feb. 1963). (In English)

A study of cerium sulfide, $Ce_{3-x}S_4$, over most of the range of composition, $0 < x < \frac{1}{3}$, has led to information about the conduction band. The compositions, determined by accurate density measurements, permitted evaluation of the electron concentration, n. The room temperature values of the electrical conductivity σ, the thermoelectric power α, and the Hall coefficient R_H were determined as a function of n over the range from 6×10^{20} to 6×10^{21} cm^{-3}. The mobility is relatively low (2 to 3 $cm^2/v\text{-sec}$), but the thermoelectric power varies as $n^{-\frac{2}{3}}$, as required by conventional theory for degenerate systems, and this permitted estimates of the effective mass and width of the conduction band. On the other hand, the Hall coefficient decreases below the value 1/ne as n is increased, indicating warping of the Fermi surface as the conduction band is filled. These results, and the analogy to transition metal oxides, suggest the possibility that the conduction band arises primarily from overlapping 5d orbitals of the cerium ions. (auth)

20710 THE FORMATION AND DISCHARGE OF CARNAUBA WAX ELECTRETS IN NUCLEAR RADIATION FIELDS. P. V. Murphy (Catholic Univ., Rio de Janeiro). Phys. Chem. Solids, 24: 329-30(Feb. 1963). (In English)

Carnauba wax electrets were partially depolarized by gamma-ray bombardment. Electrets were formed by beta irradiation in an electric field; they are called "radioelectrets". The decay current of a radioelectret is compared with these for samples electrified in the absence of radiation at 70°C and at room temperature. The residual volume polarizations were also measured for the three kinds of electrets. The similarities between the radio-

electrets and thermoelectrets indicate a common mechanism. (D.L.C.)

20711 HYDROMAGNETIC REFLECTION AND REFRACTION AT A FLUID VELOCITY DISCONTINUITY. J. A. Fejer (Southwest Center for Advanced Studies, Dallas). Phys. Fluids, 6: 508-12(Apr. 1963).

The problem of hydromagnetic reflection and refraction at a fluid velocity discontinuity is solved. Expressions for the propagation vector of the refracted wave and for the reflection coefficient are derived. It is found that the reflected and refracted waves are pure characteristic waves if the incident wave is a pure characteristic wave. (auth)

20712 HYDRODYNAMIC SHOCK TUBE. I. I. Glass and L. E. Heuckroth (Univ. of Toronto). Phys. Fluids, 6: 543-7(Apr. 1963).

An explicit solution is given to the one-dimensional hydrodynamic shock tube problem. The dynamic and thermodynamic quantities in the quasisteady states and the properties of the resulting waves are derived from the diaphragm pressure ratio and the initial conditions of the driver gas and the driven liquid. The planar flow results also apply, at the instant of diaphragm rupture, to the equivalent problem in a cylindrical or a spherical geometry, such as an underwater blast for example, and are therefore useful for establishing the initial blast properties. For this reason, some preliminary experimental data on low-energy, spherical underwater explosions are included. (auth)

20713 ORIGIN OF THE DRIVING FORCE IN ELECTROMAGNETIC SHOCK TUBES. Richard G. Fowler (Univ. of Oklahoma, Norman). Phys. Fluids, 6: 548-9 (Apr. 1963).

An explanation is offered for the failure observed by Cloupeau of ordinary shock theory in the electromagnetic shock tube. (auth)

20714 MAGNETOGASDYNAMIC FLOWS WITH SHOCK WAVES. Nima Geffen (Cornell Univ., Ithaca, N. Y.). Phys. Fluids, 6: 566-71(Apr. 1963).

A consistent small-perturbation theory for the aligned-fields, steady, magnetogasdynamic two-dimensional and axisymmetric flow of an inviscid conductor in the sonic, Alfvénic, and hypercritical regimes is developed, and approximate shock relations derived by a simple method. This results in nonlinear relatively simple systems of equations and shock relations for mixed flows around bodies in the transition regimes. It is found that transonic magnetogasdynamic problems can be reduced to gasdynamic ones; each gasdynamic transonic flow around a given body implies an infinite number of magnetogasdynamic patterns around the same body for all values of Alfvén numbers different from zero and one, and each of these, in turn, yields another family of flows around similar bodies, according to a modified von Kármán similarity rule. The hypercritical and transonic systems are mathematically similar and obey the same similarity rule. An explicit correspondence between specific transonic and hypercritical flows does not exist, but transonic arguments and methods can be used to infer qualitative properties of hypercritical flows and to obtain exact solutions of hypercritical flow patterns. (auth)

20715 ELECTRICAL CONDUCTIVITIES OF LITHIUM AND HELIUM GASES. Francis H. Ree (Univ. of California, Livermore). Phys. Fluids, 6: 579-86(Apr. 1963). (UCRL-6915)

Electrical conductivities of a multicomponent system in a uniform temperature, density, pressure, and magnetic field are obtained by using the transfer equations obtained by Burgers. The resulting formulas give the zero-order contribution to electrical conductivities by elastic scattering of colliding particles as a function of temperature and density. These formulas are applied to lithium and helium gases. The screened Coulomb cross sections and geometrical cross sections are used, respectively, for collisions involving charged particles and for collisions involving a charged particle and a neutral atom. The relative abundances of various species are obtained by using the Saha formulas. The limitations associated with the uses of the electrical conductivities are discussed. (auth)

20716 ELECTRON TEMPERATURES OF GASES IN RADIO-FREQUENCY FIELDS. Leonard S. Taylor (General Electric Space Sciences Lab., Valley Forge, Penna.). Phys. Fluids, 6: 591-2(Apr. 1963).

By means of a previous investigation of electron velocity distributions in a slightly ionized gas in the presence of an r-f field, an expression is derived for the electron temperatures of gases in r-f fields. (C.E.S.)

20717 THE EFFECT OF NON-MAGNETIC IMPURITIES ON ANISOTROPIC SUPERCONDUCTORS. M. J. Zuckermann and D. M. Brink (Clarendon Lab., Oxford). Phys. Letters, 4: 76-7(Mar. 15, 1963). (In English)

A separable anisotropic pairing potential is introduced to account for the initial decrease in the superconducting critical temperature due to nonmagnetic impurities. This decrease in the critical temperature is thought to be due to anisotropy of the pure specimen and this anisotropy is destroyed at the transition point between the weak scattering and the strong scattering regions. (C.E.S.)

20718 ON THE ONE-PARTICLE GREEN FUNCTION OF A SYSTEM OF INTERACTING PHONONS. J. J. J. Kokkedee (Universiteit, Utrecht). Phys. Letters, 4: 78-81 (Mar. 15, 1963). (In English)

Many-particle perturbation theory is used to calculate the one-phonon Green function of an anharmonic crystal to general order in the phonon-phonon coupling for all temperatures well below the melting point. This method only applies in the case that the coupling constant is sufficiently small. (C.E.S.)

20719 A VARIABLE ENERGY GAMMA RAY BEAM FOR NUCLEAR STRUCTURE STUDIES. J. A. McIntyre and G. K. Tandon (Yale Univ., New Haven). Phys. Letters, 4: 117-18(Mar. 15, 1963). (In English)

A variable-energy gamma-ray beam is described. The beam is obtained by utilizing γ rays scattered by the Compton effect. Since, in the Compton effect, there is a one-to-one correspondence between the scattering angle of the γ ray and its energy after scattering γ rays of the desired energy can be obtained for an experiment by moving the experimental apparatus to the correct scattering angle. (C.E.S.)

20720 FURTHER STUDIES ON TIME AND ENERGY AS CONJUGATE VARIABLES. Stig Hjalmars and Åke Linder (Royal Inst. of Tech., Stockholm). Phys. Letters, 4: 122-3 (Mar. 15, 1963). (In English)

A preliminary report of further investigations into Hamilton's principle for one-dimensional systems subjected to velocity-independent forces is given. The time together with the original dynamical coordinates enter as a set of proper dynamical coordinates. (C.E.S.)

20721 A F^{19} MAGNETIC RESONANCE STUDY IN XENON TETRAFLUORIDE. R. Blinc, P. Podnar, J. Slivnik, and B. Volavšek (Nuclear Institute "J Stefan", Ljubl-

jana, Yugoslavia). Phys. Letters, 4: 124(Mar. 15, 1963). (In English)

F^{19} magnetic resonance chemical shifts and second moments were measured in polycrystalline XeF_4 as a function of temperature and magnetic field to obtain information on the electronic structure and the dynamics and distribution of fluorine atoms in XeF_4. (C.E.S.)

20722 COHERENT AMPLIFICATION OF SPIN WAVES. A. I. Akhiezer, V. G. Bar'yakhtar, and S. V. Peletminskii (Khar'kov Inst. of Physics and Tech.). Phys. Letters, 4: 129-30(Mar. 15, 1963). (In English)

The possibility of raising the amplitude of spin waves without raising the temperature of the sample is considered, based on coherent interactions of electron streams with spin waves. The procedure is restricted to direct magnetic interaction. (C.E.S.)

20723 OPTICAL MASER ACTION IN EUROPIUM BENZOYLACETONATE. A. Lempicki and H. Samelson (General Telephone and Electronics Labs., Inc., Bayside, N. Y.). Phys. Letters, 4: 133-5(Mar. 15, 1963). (In English)

The observation of optical maser action in a metallo-organic complex contained in solution is reported. The new feature of this system is that the emitting ion is excited by an energy transfer process rather than by direct absorption of pump radiation. Europium benzoylacetonate crystals were studied in solution with ethyl and methyl alcohols. A high-intensity xenon flash was used for excitation. (C.E.S.)

20724 ENERGY GAPS IN SPIN-WAVE SPECTRA. A. R. Mackintosh (Ames Lab., Ames, Iowa). Phys. Letters, 4: 140-2(Mar. 15, 1963). (IS-600). (In English)

Energy gaps in the spin-wave spectra are used to calculate the temperature dependence of the saturation moment in terbium. The energy gap manifests itself at low temperatures in all properties that depend on the magnetic specific heat in a simple ferromagnet. The temperature dependence of the electrical resistivities of lutetium, terbium, dysprosium, and holmium are determined for low temperatures. (C.E.S.)

20725 QUANTUM PERIODICITY IN THE TRANSITION TEMPERATURE OF A ROTATING BOSE-EINSTEIN GAS. W. A. Little (Stanford Univ., Calif.). Phys. Letters, 4: 144-6(Mar. 15, 1963). (In English)

It is shown that if Bose-Einstein condensation is an essential feature of the λ-transition in liquid helium, then the temperature at which this transition occurs must be a periodic function of the angular momentum per particle for a rotating cylindrical sample. The magnitude of the excursions of the temperature of the λ-point are shown to be of such a size as to be measurable and relatively insensitive to interactions and scattering. (C.E.S.)

20726 ELEMENTARY EXCITATIONS IN THE VICINITY OF A NORMAL METAL-SUPERCONDUCTING METAL CONTACT. P. G. de Gennes (Faculte des Sciences, Orsay, France) and D. Saint-James. Phys. Letters, 4: 151-2(Mar. 15, 1963). (In English)

The excitation spectrum of a slab of normal metal deposited on a superconducting substrate is discussed. It is shown that if the electron-electron attractive interaction is negligibly small in the normal metal, there is no energy gap in the excitation spectrum even if the thickness of the metal slab is small. The effect may possibly explain some peculiar results of tunneling experiments on hard superconductors. (C.E.S.)

20727 GROUND STATE ENERGY OF AN ELECTRON GAS IN A LATTICE OF POSITIVE IONS. M. de Leener and A. Bellemans (Université, Brussels). Phys. Letters, 4: 157-9(Apr. 1, 1963). (In English)

The simple Coulomb potential used to represent the interactions between electrons and lattice charges is replaced by an effective potential. With this potential, the ground state energy of an electron gas in a pure lattice built from identical ions is evaluated. This calculation is generalized to the case of equimolecular mixtures where the two types of sites form a superlattice and of disordered lattices in the random-mixing approximation. (C.E.S.)

20728 ELECTRON DETACHMENT FROM H^- BY ELECTRONS. M. R. C. McDowell and J. H. Williamson (Univ. of London). Phys. Letters, 4: 159-60(Apr. 1, 1963). (In English)

The accuracy of the modified Bethe-Born approximation was tested by computing the cross section for ionization of atomic hydrogen by electron impact in this approximation. The results were in excellent agreement with the very elaborate calculations of Peterkop and others. (C.E.S.)

20729 A NOTE ON GREEN FUNCTIONS AND THE ISING MODEL. H. B. Callen (Univ. of Pennsylvania, Philadelphia). Phys. Letters, 4: 161(Apr. 1, 1963). (In English)

A somewhat simpler and more transparent set of identities for the Ising model of ferromagnetic materials results from considering Green functions defined in terms of anti-commutators rather than commutators of the relevant operators. (C.E.S.)

20730 DOUBLE-PHOTON PHOTO-DETACHMENT OF NEGATIVE IONS. S. Geltman (Joint Inst. for Laboratory Astrophysics, Boulder, Colo.). Phys. Letters, 4: 168-9 (Apr. 1, 1963). (In English)

It is shown that the unique level structure of a negative ion leads to a considerable simplification in the theoretical evaluation of the magnitude of the transition probability. This simplification is used to obtain an expression for the double-photon photo-detachment probability in terms of the single-photon probability for a transition to the same final state. (C.E.S.)

20731 THERMAL BOUNDARY RESISTANCE BETWEEN SOME SUPERCONDUCTING AND NORMAL METALS. L. J. Barnes and J. R. Dillinger (Univ. of Wisconsin, Madison). Phys. Rev. Letters, 10: 287-9(Apr. 1, 1963).

Measurements of the thermal resistance at the boundary between tin and copper and between lead and copper for cases in which the tin and lead are superconducting and normal are reported. (C.E.S.)

20732 MEASUREMENT OF THE TEMPERATURE OF FLAMES BY THE METHOD OF INVERSION OF SPECTRAL LINES. Dionizy Smolenski and Mieczyslaw Seweryniak (Wroclaw Technical Univ., Poland). Postepy Fiz., 13: 637-64(1962). (In Polish)

The measurement of flame temperatures has recently become of major importance in such applications as turbojets, rockets, and other applications where a knowledge of the burning process and of the factors that determine efficient burning are of great importance. The method employs an optical scheme of displaying one or more spectral lines on a screen. The lines are caused by passing the light of a ribbon-filament lamp (of variable optical temperature) through a flame that selectively absorbs the sodium lines, for example, if sodium is present in the flame. The absorption varies with temperature, and this leads to a disappearance of the lines (sodium) when the flame temperature is the same as that of the ribbon filament that emits the light. An optical pyrometer then determines the ribbon temperature. An optical pyrometer then de-

termines the ribbon temperature. The many favorable elements giving line or band spectra that have been useful in several historic stages of the development of this process are mentioned. There is also presented such topics as the theoretical basis of the process, isothermicity and the state of thermal equilibrium in the flame, the resonance contour of line spectra and nonisothermicity of the flame, variants of apparatus used in the method of inversion, and temperature of inversion compared to the theoretical temperature. When applied manually, the method is slow. However, electronic techniques have been applied to the sensing, measuring, and registering the temperature with sensing or sampling times that are as short as one microsecond. (TTT)

20733 PHOTO-IONIZATION CROSS SECTION MEASUREMENTS ON LITHIUM. G. V. Marr (Reading Univ., Eng.). Proc. Phys. Soc. (London), 81: 9-11(Jan. 1, 1963).

Atomic cross section measurements are reported for the continuous absorption of radiation from the series limit at 2300 to 1450 Å. The best value obtained at the series limit is 1.7 ± 0.4 Mb, and the shape of the curve is in general agreement with the more recent theoretical predictions. (auth)

20734 THE LUMINESCENCE FROM RUBY EXCITED BY FAST ELECTRONS. E. W. J. Mitchell and P. D. Townsend (Reading Univ., Eng.). Proc. Phys. Soc. (London), 81: 12-14(Jan. 1, 1963).

The spectrum of the luminescence from ruby excited by 2 Mev electrons was compared with that excited by ultra-violet light. Two effects were noted: an additional pair of lines at 7165 and 7218 Å, and an asymmetric broadening on the long-wavelength side of the R_1R_2 doublet. The first effect is attributed to multiple ionizing in the neighborhood of a chromium atom, and the second to local heating by the electron beam. (auth)

20735 THE CORRELATION ENERGIES OF EXCITED STATES OF THE HELIUM SEQUENCE. R. Perrin and A. L. Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 28-34(Jan. 1, 1963).

The method of superposition of configurations is used to determine the contributions from radial and angular correlation to the second-order term in the expansion of the energies of excited states of the two-electron systems in inverse powers of the nuclear charge. Comparison with the similar calculation carried out by Sharma and Coulson in 1962 using an expansion in terms of Hylleraas coordinates shows that the superiority of the method of incomplete separation of variables over the method of superposition of configurations is not so pronounced as for the ground state. The contributions to the second-order energy of the $1s2s\,^1S$, $1s2s\,^3S$, $1s2p\,^1P$ and $1s2p\,^3P$ states from correlation are found to be −0.0180, −0.0041, −0.0068 and −0.0069 rydberg respectively, compared with the Hartree–Fock contributions −0.2068, −0.0906, −0.2931 and −0.1358 rydberg respectively. Third-order terms are also calculated. (auth)

20736 QUANTUM DEFECTS AND SCATTERING LENGTHS. B. L. Moiseiwitsch (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 35-40(Jan. 1, 1963).

The evaluation of quantum defects and scattering lengths is discussed and formulas relating these quantities are derived using first-order perturbation theory and effective range theory. (auth)

20737 PEAK BRIGHTNESS TEMPERATURES AND INTENSITY MEASUREMENTS IN A SHORT DURATION SPARK SOURCE. E. M. Reeves (Imperial Coll., London). Proc. Phys. Soc. (London), 81: 47-51(Jan. 1, 1963).

The measurements of the peak brightness temperature and spectral energy distribution of a high-energy, short-duration spark discharge source are described. The measurements indicate a peak brightness temperature of 54,000 to 68,000 °K over the wavelength region from 4500 to 3000 Å. (auth)

20738 THE MOTION OF A CHARGED PARTICLE IN A TIME-VARYING AXIAL MAGNETIC FIELD. M. G. Haines and D. W. Allan (Imperial Coll. of Science and Tech., London). Proc. Phys. Soc. (London), 81: 104-16 (Jan. 1, 1963).

An analysis of the motion of a charged particle in a uniform time-varying axial magnetic field is made assuming cylindrical symmetry. A sinusoidal time variation is studied in particular, and the non-relativistic case gives a special form of Mathieu's equation. For large values of the parameter ω_c/ω the solution may be divided into two regimes, essentially non-adiabatic and adiabatic, which are matched asymptotically. In this case the diameter of the orbit is very insensitive to the parameter. The relativistic case is attempted and a correction to the asymptotic solution is found. Several examples of orbits are drawn and the results are applied to the B_z pinch and to the acceleration of cosmic-ray particles. (auth)

20739 THE EFFECT OF ABSORBED GASES ON PROTON INDUCED ELECTRON EMISSION FROM TITANIUM. L. N. Large (Services Electronics Research Lab., Admiralty, Baldock, Herts, Eng.). Proc. Phys. Soc. (London), 81: 175-80(Jan. 1, 1963).

The secondary electron coefficient γ for ions in the energy range 10–130 kev incident on titanium was investigated. The effect of controlled pressures of oxygen, hydrogen, and nitrogen was studied using degassed surfaces. The effect of air at atmospheric pressure was also observed. It was observed that exposure of a degassed titanium surface to oxygen pressures as low as 2×10^{-6} mm Hg is sufficient to raise γ for 100 kev protons by 40%. The effect of nitrogen was also to increase γ, providing that the titanium was made to absorb it in sufficient quantity by heating. Hydrogen increased the emission by a small amount when the surface concentration was high enough. When titanium was oxidized in air at atmospheric pressure the secondary emission increased rapidly during the initial exposure, but after a few minutes the rate of increase of γ for 100 kev protons was very slow. Possible explanations are discussed in relation to a theory by Sternglass. It is concluded that the results cannot be explained in terms of one basic process changing, but that contributory factors are an increase in the rate of loss of energy with distance of the impinging ion where the gas is absorbed, and more favorable conditions for diffusion of low-energy electrons to the surface. (auth)

20740 INTEGRABLE TRANSFORMATIONS BETWEEN MOVING OBSERVERS. D. J. Cashmore (British Aircraft Corp., London). Proc. Phys. Soc. (London), 81: 181-5 (Jan. 1, 1963).

It is shown that for events anywhere in space–time, the only integrable point transformations between rectilinearly moving observers that hold in a flat space, and preserve a universally constant speed of light, are those for observers moving relatively in one of three special ways. The simplest case is that of uniform relative motion. In the other two cases, the relative motion is more complicated, but is none the less specified in form. It follows that to extend Gordon's theory or special relativity to non-uniform motion, integrability can only be preserved by abandoning one or both of the basic postulates. Alternatively, if the postulates are retained, the theories would have to be extended on the basis of non-integrable transformations. (auth)

20741 GLOCKLER'S EQUATION FOR IONIZATION POTENTIALS AND ELECTRON AFFINITIES. R. J. S. Crossley and C. A. Coulson (Oxford Univ.). Proc. Phys. Soc. (London), 81: 211-18(Feb. 1, 1963).

A theoretical study is made of an equation proposed by Glockler in 1934 for the variation of the ionization potentials and electron affinities of atomic systems with their atomic number Z. Writing $I = \alpha Z^2 + \beta Z + \gamma$, formulas are given that enable α and β to be calculated. A table is included of Coulomb and exchange integrals for hydrogenic wave functions up to 4f orbitals. It is shown that γ is almost constant over an isoelectronic series, varying only slowly with Z. The method is superior to other methods recently proposed for determining electron affinities. A correction is suggested for the ionization potential of Ar^{8+}, and certain other ionization potentials and electron affinities are calculated and given in a table. (auth)

20742 A REVISED CALCULATION OF THE VELOCITY OF SOUND IN LIQUID HELIUM. A. Crowe (Oxford Univ.). Proc. Phys. Soc. (London), 81: 320-2(Feb. 1, 1963).

Bogolyubov has made a transformation of the hamiltonian of a system of Bose-Einstein particles so that it is expressed as the energies of a system of quasi particles. A modification of this transformation is suggested in order to take into account interaction energies for the smallest particle separations. This enables a revised formula for the velocity of sound to be obtained, which, when applied to the case of liquid helium, gives a value of 80.5 m sec^{-1}. This value is much nearer the experimentally determined value than that obtained when the formula derived by Bogolyubov's original transformation is used. (auth)

20743 A NEW NON-QUADRUPOLE TRANSITION IN THE L SPECTRUM OF THORIUM 90. G. B. Deodhar and B. D. Padalia (Univ. of Allahabad, India). Proc. Phys. Soc. (London), 81: 367-8(Feb. 1, 1963).

The L spectrum of thorium-90 was studied with special attention directed to the missing transitions L_IM_I and $L_{II}N_{II}$. Careful measurements of various spectrograms revealed that, in addition to the forbidden transitions known previously, the non-quadrupole transition L_IM_I was found to exist. Numerous attempts were made to record the $L_{II}N_{II}$ line but no trace of this transition was observed. (C.E.S.)

20744 ELECTRON IMPACT IONIZATION OF ATOMIC HYDROGEN. S. Geltman (Joint Inst. for Laboratory Astrophysics, Boulder Colo.), M. R. H. Rudge, and M. J. Seaton. Proc. Phys. Soc. (London), 81: 375-8(Feb. 1, 1963).

Two problems in the theory of ionizing collisions are considered: the treatment of electron exchange; and allowance for long-range potentials in the final state, particularly as they affect the threshold law. Considerable simplification results from considering these two problems separately. (C.E.S.)

20745 WEAK-BINDING APPROXIMATION IN A ONE-DIMENSIONAL LIQUID CHAIN. A. P. Roberts (Univ. of Sydney). Proc. Phys. Soc. (London), 81: 416-26(Mar. 1, 1963).

The validity of the nearly-free electron (weak-binding) approximation is considered, for the problem of a single electron in a one-dimensional chain of potential wells lacking long-range order (a liquid chain), over an energy range forbidden for a periodic chain of the same mean spacing. Central limit theorems for sums of dependent variates are used to obtain the probability distribution of the Fourier components of the potential. It is shown that the findings justify a definite evaluation of the potential power spectrum. A second-order expression for the energy, in weak-binding approximation, is then evaluated. The implied eigenstate density is compared with the results of Monte Carlo calculations for chains of δ-function wells. The comparison shows the fit to be good for large disorders, but very poor for small disorders. The findings are explained in the light of knowledge regarding localized states in this energy region. The trial wave function used in the weak-binding approach can approximate to a localized state, but only for disorders large enough to destroy the gap. The relevance of this finding to work with real liquids is discussed. (auth)

20746 ISOTOPE SHIFT IN Li AND B^{2+}. M. R. Flannery and A. L. Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 431-5(Mar. 1, 1963).

The mass polarization or specific isotope shift of the $1s^22s\ ^2S$ and $1s^22p\ ^2P$ levels of Li and B^{2+} is calculated using open-shell type wave functions and the shifts of the resonance lines of Li^7 relative to Li^6 and doubly ionized B^{11} relative to doubly ionized B^{10} are estimated to be 0.100 cm^{-1} and 0.688 cm^{-1} respectively compared with the observed values 0.157 cm^{-1}, 0.930 cm^{-1} ($\Delta J = 0$) and 0.970 cm^{-1} ($\Delta J = 1$). The results are also compared with the values obtained using an alternative form of the mass polarization operator. (auth)

20747 HYPERFINE SPLITTING OF THE GROUND STATE OF LITHIUM-LIKE IONS. A. L. Stewart (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 436-8 (Mar. 1, 1963).

The hyperfine splitting of the $1s^22s\ ^2S$ states of the three-electron systems is calculated using the simplest form of open-shell wave functions. The result for lithium is in good agreement with the very accurate calculation of Nesbet and with experiment. The values for the isoelectronic sequence can be closely represented by an expansion in powers of Z^{-1}. (auth)

20748 SOME CALCULATIONS OF OBSERVABLES BASED ON THE SCHWARTZ METHOD. R. J. Weiss (Imperial Coll., London). Proc. Phys. Soc. (London), 81: 439-41(Mar. 1, 1963).

The Schwartz method was extended to calculations of the x ray scattering factor, $\langle r \rangle$ and $\langle 1/r^2 \rangle$ for the ground state of helium and to $\langle \delta(r) \rangle$ for the triplet state of helium, all with good accuracy. It is shown that the Schwartz method fails for a trial wave function that does not satisfy the virial theorem. (auth)

20749 THE DETERMINATION OF PHASES AND AMPLITUDES OF WAVE FUNCTIONS. A. Burgess (London Univ.). Proc. Phys. Soc. (London), 81: 442-52(Mar. 1, 1963).

The asymptotic forms of the positive energy solutions of the radial Schrödinger equation for a modified Coulomb field are investigated, using both the Jeffreys or WKB method, and the analytic properties of the solutions for an unmodified Coulomb field. The neutral case is also treated. Analytic expressions for the phases associated with modifying potentials of the form $\alpha r^{-2} + \beta r^{-3} + \gamma r^{-4}$ are obtained, so that the phases and amplitudes of solutions may easily be determined, to sufficient accuracy for most purposes, for any potential of physical interest. A short table of regular and irregular Coulomb functions is given. (auth)

20750 ON THE SPACE-TIME DISCONTINUUM. REMARKS CONCERNING THE $h-c-l_0$ THEORIES. Karl Stiegler. Proc. Phys. Soc. (London), 81: 478-9(Mar. 1, 1963).

It is shown that the introduction of the quantum of length

l_0 and of the universal constant c, the velocity of light in vacuo, into a physical theory is equivalent to the hypothesis that the space–time has a discontinuous structure. (auth)

20751 THE INTERPRETATION OF BREAKDOWN CHARACTERISTICS OF ELECTRODELESS DISCHARGES IN TRANSVERSE MAGNETIC FIELDS. H. A. Blevin and S. C. Haydon (Univ. of New England, Armidale, N.S.W., Australia). Proc. Phys. Soc. (London), 81: 490-2(Mar. 1, 1963).

It was suggested that the equivalent pressure concept for the influence of a transverse magnetic field on electrical breakdown in uniform fields can be extended to explain the phenomena observed recently in electrodeless discharges. It is pointed out that these measurements are possibly unreliable because of a restricted E × H drift of electrons and the consequent influence of the tube walls. A comparison of theory and experiment on the basis of such measurements is therefore unsatisfactory. (auth)

20752 A TEMPERATURE INSTABILITY IN MAGNETOHYDRODYNAMIC FLOW. J. K. Wright (Central Electricity Research Labs., Leatherhead, Surrey, Eng.). Proc. Phys. Soc. (London), 81: 498-505(Mar. 1, 1963).

In magnetohydrodynamic systems where the electrical conductivity increases with temperature, a temperature instability may occur due to preferential ohmic heating of the hotter parts of the plasma. The rate of growth of this instability is discussed with particular reference to magnetohydrodynamic generators. It is shown that different results are obtained on the single-fluid and two-fluid (electrons treated separately from the atoms and ions) models but in both cases the rate of growth is too slow to be important in practical magnetohydrodynamic generators. A related problem of the rate of obtaining enhanced conductivity in magnetohydrodynamic generators is also discussed and it is shown that the conductivity increases in the first fraction of the duct. (auth)

20753 THE SPECTRA OF Ne IV, Ne V, AND Ne VI: A FURTHER ANALYSIS. S. Goldsmith and A. S. Kaufman (Hebrew Univ., Jerusalem). Proc. Phys. Soc. (London), 81: 544-52(Mar. 1, 1963).

From spectrograms taken with the high-current discharge assemblies Sceptre III and IV, new lines of Ne(IV), Ne(V), and Ne(VI) in the range between about 2200 and 3000 Å were observed and classified. The lists of classified lines and term values, both new and revised, are given in tabular form. No intersystem combinations were observed in any of the three spectra. A method of distinguishing the higher stages of ionization (Ne(IV), Ne(V), Ne(VI)) was developed by varying the concentration of the neon added to the deuterium. The relative intensities of the spectra vary with the concentration in a characteristic manner and so the lines of a given spectrum can be picked out with comparative ease. A theoretical explanation of the effect is advanced on the assumption that the plasma is cooled by spectral-line radiation. Methods of identifying the stage of ionization when high-current discharges are used as spectral sources are appraised. (auth)

20754 PARTICLE FOCUSING PROPERTIES OF THE PROLATE SPHEROIDAL MAGNETIC FIELD AND OF THE SUPERPOSED SPHEROIDAL AND UNIFORM FIELDS. Dvora Michelson and H. O. W. Richardson (London Univ.). Proc. Phys. Soc. (London), 81: 553-70(Mar. 1, 1963).

Values of transmission T and resolution W are computed for prolate spheroidal field magnetic spectrometers with various positions of the source. A value of 15% of 4π was found for T with W = 1%. The aberration due to size of source was estimated by computing trajectories from non-axial points. Envelopes and caustics formed by monoenergetic families of rays are mapped for several magnetic rigidities. The focusing of particles in superpositions in various ratios of a prolate spheroidal and uniform field with a common axis is considered. It appears that the position of a point image I of an axial point object O is unrestricted except to the extent that O and I must lie between the foci of the spheroids on the axis and that a narrow zone of angles of emission is used. A β spectrometer using one such ratio is found to give a poorer aperture aberration but an improved source size aberration when compared with the pure spheroidal field instrument. In each case the luminosity is similar to that of the uniform field lens spectrometer. (auth)

20755 RIEMANNIAN SPACES OF N DIMENSIONS, WHICH CONTAIN FERMI SUBSPACES OF N−1 DIMENSIONS. L. O'Raifeartaigh (Dublin Inst. for Advanced Studies). Proc. Roy. Irish Acad., Sect. A, 62: 63-72 (Nov. 1962).

A condition for the existence of Fermi coordinates derived in a previous paper is used to establish some theorems concerning Riemannian spaces of N dimensions, V_N, which contain Fermi subspaces of N−1 dimensions, F_{N-1}. It is hoped that these theorems will help to give a somewhat deeper understanding of what the existence of an F_{N-1} implies in terms of familiar quantities such as the Einstein tensor. (auth)

20756 ON A GENERALISED COMMUTATION RELATION. L. O'Raifeartaigh (Dublin Inst. for Advanced Studies) and C. Ryan. Proc. Roy. Irish Acad., Sect. A, 62: 93-115(Jan. 1963).

The method of the complete set is used to study a generalized commutation relation. This commutation relation is of interest for two reasons. First, it is very similar to the commutation relations considered by various authors in connection with generalized statistics. Secondly, it allows us to investigate further a problem previously considered by Wigner, namely, "Do the equations of motion determine the quantum mechanical commutation relations?" (auth)

20757 THE MASS SPECTRAL CONDITION AND ANALYTIC PROPERTIES OF THE VERTEX FUNCTION. [PART] II. Gaku Konisi (Kwansei Gakuin Univ., Nishinomiya, Japan). Progr. Theoret. Phys. (Kyoto), 28: 988-90 (Dec. 1962). (In English)

The domain of analyticity of the vertex function as a function of three complex variables is discussed in the frame of the axiomatic theory of fields. The method supplies knowledge about the case in which the three lower limits on the mass spectra of the intermediate states are different from each other. (auth)

20758 MOTION OF STRONGLY COUPLED ELECTRON-LATTICE SYSTEMS. Tatsumi Kurosawa (Chuo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto), 29: 159-90(Feb. 1963). (In English)

Properties of strongly coupled electron-lattice systems are studied. The interrelation between hopping and wave-like motions is examined. At sufficiently low temperatures, the motion of such systems is predominantly wave-like and becomes that of a polaron in a general sense. The effective mass of the motion increases exponentially with the coupling constant if the interaction is strong, whereas it is proportional to the fourth power of the coupling constant in polar crystals of intermediate interaction as shown by Landau and Pekar. At moderate temperatures, the motion

of the system is partially wave-like and partially hopping. Mobility tensors and Hall coefficients of such systems are calculated under assumptions that may be fulfilled in the strong coupling cases. (auth)

20759 RESONANCE SCATTERING OF LATTICE WAVES BY ISOTOPES. Shozo Takeno (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 29: 191-205 (Feb. 1963). (In English)

An investigation is made of the scattering of lattice waves by isotopes in a Bravais lattice by studying classical time-independent equations of motion for the displacement of atoms from their equilibrium positions. Expressions for the cross section or the intensity, of a scattered wave by an isolated isotope and by a pair of isotopes are obtained from the solutions of the equations of motion. It is shown that a resonance scattering occurs when the difference between the mass of an atom of the host crystal and that of an isotope exceeds a certain critical value. The Rayleigh scattering formula obtained by Pomeranchuk and Klemens is shown to be valid only when the mass difference is small. As a model, a simple cubic lattice with the nearest neighbor interaction is studied in detail, and the scattering cross section as well as the intensity of the scattered wave is evaluated explicitly as a function of the frequency and the mass difference. It is suggested that a very heavy isotope causes a sharp resonance scattering in the low frequency region, and in the high frequency region a resonance scattering occurs only when the mass of the isotope is so small that it causes a localized mode. (auth)

20760 ON THE LANDAU THEORY OF SUPERFLUIDITY. Nobuyuki Fukuda, Kenji Fukushima, and Tadasi Inagaki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 206-12(Feb. 1963). (In English)

Landau's criterion for superfluidity is re-examined by taking into account the interaction between the system and the wall explicitly. Provided that the excitation of the system at rest is described in terms of the quasiparticle with the spectrum $\epsilon(k)$, the system that is moving below the critical velocity, min $\{\epsilon(k)/k\}$, can never lose its velocity by creating quasiparticles. In order to obtain this result, the Galilei transformation which brings the system to rest is applied. Then the wall is moving and its moving field can transfer to the system not only the momentum but also the energy. The new form of the conservation law of energy leads to Landau's criterion. (auth)

20761 THE EVOLUTION EQUATION OF QUANTUM GASES. Lesser Blum (Facultad de Ciencias Exactas y Naturales, Buenos Aires). Progr. Theoret. Phys. (Kyoto), 29: 213-20(Feb. 1963). (In English)

The terms of the series obtained by iteration of the von Neumann's equation for a quantum gas are summed by a method that groups only connected and disconnected diagrams. The main hypothesis made is random a priori phases at the initial time $t_0 = 0$; if the repeated random a priori phases are diagonal at a time t, too the Pauli equation is obtained, provided this time t is much longer than the collision time. (auth)

20762 QUANTIZATION OF THE GRAVITATIONAL FIELD IN THE EXPANDING UNIVERSE. Hidekazu Nariai and Toshiei Kimura (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 29: 296-320(Feb. 1963). (In English)

An attempt is made to quantize, in the linear approximation, the gravitational field in the expanding universe, from the standpoint of canonical formalism. By using a transformation function and decomposing suitably the field operator into positive and negative frequency parts, explicit forms of the four-dimensional commutation function and the propagation function are derived in the case of three special world models. There appears the difficulty of divergence term in the propagation function, with the exception of one model. The propagation function, however, satisfies the relation between Hadamard's elementary solution and the propagation function postulated by De Witt and Brehme. In addition, a connection between the propagation function and the time-ordered product of field operators is established by introducing a state of quasi-vacuum in parallel with our decomposition mentioned above. Finally, detailed discussions of several difficulties are given in connection with the problem of causality. It is suggested from the analysis that the quantum theory and the general relativity cannot rigorously be compatible, so far as the hypothesis of the expanding universe is concerned. (auth)

20763 FREQUENCY SPECTRUM OF A LATTICE WITH HEAVY ISOTOPES. Shozo Takeno (Hokkaido Univ., Sapporo). Progr. Theoret. Phys. (Kyoto), 29: 328-30 (Feb. 1963). (In English)

An anomaly of the frequency spectrum of a cubic Bravais lattice associated with heavy isotopes of a single kind is shown. (C.E.S.)

20764 PROTECTION OF SUPERCONDUCTING COILS. P. F. Smith (Rutherford High Energy Lab., Harwell, Eng.). Rev. Sci. Instr., 34: 368-73(Apr. 1963).

Superconducting magnets of sufficiently high inductance can be damaged by overheating during an accidental transition to the resistive state. Possible protection circuits are analyzed theoretically, and some of the practical consequences of the analysis are summarized. (auth)

20765 CONTAMINATION IN ULTRA-HIGH VACUUM PLANT. L. Holland, L. Laurenson, and C. Priestland (Edwards High Vacuum Ltd., Crawley, Eng.). Rev. Sci. Instr., 34: 377-82(Apr. 1963).

Using an electron bombarded target, the presence of silicone vapor was detected in the vessel of a bakeable ultra-high vacuum system made of stainless steel exhausted by a silicone oil diffusion pump. Silicone molecules temporarily adsorbed on the target were desaturated by the impinging electrons and polymerized to form a deposit. The deposit thickness was measured by multiple-beam interferometry. The diffusion pump was charged with silicone 704 and fitted with a chevron (trap II) and a container trap (trap I) next to the vessel. Liquid nitrogen cooling both the chevron and container-type trap next to the vessel after baking ($p_{ultimate} \simeq 10^{-9}$ Torr) gave a deposit growth rate of <5 Å/hr. When the chevron trap was not operated during ultra-high vacuum pumping, the container-type trap condensed sufficient oil vapor for the vessel to be contaminated when the vessel and trap were subsequently baked. The contamination rate measured during baking was dependent on the time the system had been previously under ultra-high vacuum without the chevron trap being cooled. Ultra-high vacuum pumping for 38 hr at 10^{-9} Torr gave rise to a deposit growth rate of 160 Å/hr on the next baking cycle. The contamination rate was reduced to its lowest amount during baking (35 Å/hr) when the chevron baffle was cooled throughout the pumping cycle. Using a new silicone fluid (705) gave a deposit growth rate of about one-half to one-quarter of fluid 704. (auth)

20766 X-RAY TUBE WITH A BUILT-IN SECONDARY TARGET FOR EXCITING K LINES. Bertil Jacobson and Lars Nordberg (Karolinska Institutet, Stockholm). Rev. Sci. Instr., 34: 383-5(Apr. 1963).

A special continuously pumped x-ray tube was developed for producing high intensities of characteristic K-emission

lines. The rotating primary target consists of a gold-plated copper cylinder, which is water-cooled. The conical secondary target is placed inside the primary target and close to it so as to achieve a high output yield. With the tube windows used at present, wavelengths between 0.1 and 0.5 Å can be produced by choosing the appropriate elements for the secondary target. To obtain a high purity of the radiation, the tube voltage should be less than three times the minimum excitation potential for the K radiation in question. The x-ray yield is 10^8 to 10^9 quanta/ma-sec-sterad. (auth)

20767 ACHROMATIC MAGNETIC MIRROR FOR ION BEAMS. Harald A. Enge (Massachusetts Inst. of Tech., Cambridge). Rev. Sci. Instr., 34: 385-9(Apr. 1963).

A new type achromatic or nearly achromatic deflecting magnet for ion beams is discussed. The magnetic field in the x-y (median) plane is given by $B = 0$ for $x < 0$ and $B_z = Gx^n$ for $x > 0$. The particles enter the field through the origin at an angle α with the x axis, go through a loop of $180° + 2\alpha$, and leave the field by again crossing the y axis at the origin or close to the origin. Several cases are studied with the field exponent $n = 1$ or close to unity and with deflection angle 270° (90°) or nearly so. (auth)

20768 CONTINUOUSLY OXYGENATED TUNGSTEN AS A SURFACE IONIZATION SOURCE. C. A. Haque and E. E. Donaldson (Washington State Univ., Pullman). Rev. Sci. Instr., 34: 409-12(Apr. 1963).

A surface ionization source with a controlled work function was produced by exposing a polycrystalline tungsten filament to a steady flow of oxygen. The displacement of characteristic method was used to determine its electron work function at different temperatures. The data are supported by the evidence of surface ionization of aluminum. (auth)

20769 IMPROVING THE TUNNEL DIODE UNIVIBRATOR. Albert L. Whetstone (Univ. of Pennsylvania, Philadelphia). Rev. Sci. Instr., 34: 412-13(Apr. 1963).

Experience has shown that nanosecond logic operations such as fan-in, fan-out, coincidence, and pulse discrimination can be performed with tunnel diode univibrators with a resulting economy and simplicity. A method of reducing or controlling the deadtime of the univibrator is presented with the result that the logic operations can be carried out on pulse pairs spaced well under 10 nsec. (auth)

20770 SIMPLE METHOD OF OVERCOMING THE EFFECTS OF NOISE SIGNALS PRODUCED BY SPARK GAP SWITCHES. F. L. Curzon and C. C. Daughney (Univ. of British Columbia, Vancouver, Can.). Rev. Sci. Instr., 34: 430-1(Apr. 1963).

A simple spark gap switch is designed in which only the trigger spark produces a noise signal, and this signal decays before the main conduction channel in the switch is formed. The switch was tested with a pinch discharge device. (D.L.C.)

20771 RESIDUAL-GAS CONCENTRATIONS IN EVACUATED CHAMBERS. Joseph C. Bowe (Argonne National Lab., Ill.). Rev. Sci. Instr., 34: 443-4(Apr. 1963). (TID-17849; UAC-7078)

Belofsky's mathematical treatment of the diminution of residual atmospheric gases in a closed system by continuous purging, is discussed. A differential equation and its solution are given for the evacuation of a chamber. It is shown that no significant reduction in the O_2 concentration is attained by successively pumping and refilling the chamber more than a few times. Continuous purging per se is of no advantage if the only requirement is that the atmospheric gases should be reduced to very low concentrations. Where gas purity is concerned, i.e., the concentrations of all foreign gases must be kept below certain limits, continuous or cyclic purging is of no help in a closed system. (D.L.C.)

20772 SOME COMMENTS ON THE MAXWELL RELATIVISTIC DISTRIBUTION. N. B. Maslova. Vestn. Leningr. Univ., No. 19, Ser. Mat. Mekh. i Astron. No. 4, 156-9(1962). (In Russian)

The relation between Maxwell relativistic distribution parameters and the thermodynamic parameters of a gas is found. (auth)

20773 THE REGENERATION OF RADIOLUMINOPHORS. J. Cabicar and F. Einhorn. Z. Naturforsch., 18a: 92-3(Jan. 1963). (In German)

Signs of deterioration of radioluminophors of the ZnS group were traced to structural changes caused by radiation. Previous studies indicated the possibility of the regeneration of radioluminophors by a periodically regulated heat treatment. The light intensity of the phosphors after ultraviolet excitation was determined after heating at 350 or 550°C for different lengths of time. A dependence of degree of regeneration on length of heating was found. An increase of the radioluminescence up to about 400% was obtained. (M.C.G.)

20774 EVALUATION OF MAXIMUM CRITICAL FIELDS IN STRONG SUPERCONDUCTORS. L. P. Gor'kov (Inst. of Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 767-9(Feb. 1963). (In Russian)

High critical fields ($\sim 10^5$ gauss) were recently reported for a series of superconductors. An analysis was made of the maximum possible critical magnetic fields at weak current. The results showed that for pure superconductors the critical field does not exceed 10^2 to 10^3 gauss, while for superconducting alloys the maximum possible critical field is 10^4 T^0 gauss. (R.V.J.)

20775 INVESTIGATION OF VOLUME RECOMBINATION IN A CESIUM PLASMA. Yu. M. Aleskovskii (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 840-7 (Mar. 1963). (In Russian)

Probe and spectrometric determinations of the recombination coefficient α and electron temperature T_e are performed for a disintegrating cesium plasma. No dependence of α on ρ was found in the pressure range investigated between $\rho = 5 \times 10^{-3}$ and 10^{-1} mm Hg. An analysis of the results reveals that recombination occurs in the triple collision of two electrons + ion. An important role in the recombination mechanism is played by step transitions due to collisions of the second kind. The recombination coefficient was computed for a plasma with a density of $10^{11}-10^{14}$ cm^{-3} and temperature $T_e = 0.1-0.3$ ev and found to agree satisfactorily with the experimental results. (auth)

20776 NONSYMMETRIC ULTRAVIOLET ASYMPTOTIC EXPRESSIONS FOR HIGHER GREEN FUNCTIONS IN RENORMALIZED THEORY. I. F. Ginzburg (Inst. of Mathematics with Computor Center, Siberian Academy of Sciences, SSR). Zh. Eksperim. i Teor. Fiz., 44: 894-8 (Mar. 1963). (In Russian)

Nonsymmetric ultraviolet asymptotic expressions for multiparticle Green functions in the nonphysical region ($\varphi_i^2 \to \infty$) are defined by diagrams with exchange of a minimal number of particles. The asymptotic expressions are obtained with a power accuracy. (auth)

20777 RADIATION EMITTED BY ATOMS MOVING IN THE FIELD OF A STANDING WAVE. S. G. Rautian

and I. I. Sobel'man (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 934-45(Mar. 1963). (In Russian)

The radiation from atoms moving in the field of a standing wave is considered. The expressions obtained are employed for calculating the power of the stimulated and spontaneous radiation of a gas quantum generator. (auth)

20778 CONTRIBUTION TO THE THEORY OF SINGULARITIES IN NONLINEAR ELECTRODYNAMICS. S. V. Peletminskii. Zh. Eksperim. i Teor. Fiz., 44: 1023-35 (Mar. 1963). (In Russian)

The structure of the singularities in nonlinear electrodynamics is investigated. Equations of motion of the singularities are derived without making any significant assumptions regarding the concrete form of the Lagrangian of the electromagnetic field. (auth)

20779 CRYSTAL STRUCTURE OF SOME U AND Th COMPOUNDS. E. G. Arutyunyan and M. A. Porai-Koshits (Kurnakov Inst. of General and Inorganic Chemistry, USSR). Zh. Strukt. Khim., 4: 110-11(Jan.-Feb. 1963). (In Russian)

An x-ray diffraction analysis was made of the crystal structure of $Cs_3[UO_2(NCS)_5]$, $Cs_4[U(NCS)_8] \cdot 2H_2O$, $Cs_4[Th(NCS)_8] \cdot 2H_2O$, and $K_4[Th(SO_4)_4] \cdot H_2O$. For $Cs_3[UO_2(NCS)_5]$ space group pnma = D_{2h}^{16}, the lattice parameters are a = 13.629 ± 0.004, b = 13.249 ± 0.006, and c = 11.556 ± 0.004 Å; for $Cs_4[U(NCS)_8] \cdot 2H_2O$, Pnab, a = 13.15, b = 13.20, c = 15.75 Å, N = 4; for $Cs_4[Th(NCS)_8] \cdot 2H_2O$, $P2_1/n$, a = 13.520, b = 13.696, c = 16.226 Å, $\beta = 90°$, and N = 4; and for $K_4[Th(SO_4)_4] \cdot 2H_2O$, $C\bar{1}$, a = 10.0, b = 16.5, c = 9.7 Å, $\alpha = 93°22'$, $\beta = 95°35'$, $\gamma = 91°09'$, and N = 4. (R.V.J.)

20780 CRYSTAL STRUCTURE OF RUTHENIUM NITROSOPENTAMINETRICHLORIDE. T. S. Khodashova (Kurnakov Inst. of General and Inorganic Chemistry, Academy of Sciences, USSR). Zh. Strukt. Khim., 4: 111-12(Jan.-Feb. 1963). (In Russian)

The crystal structure of 0.20 to 0.25 mm spherical specimens of $[RuNO(NH_3)_5]\ Cl_3 \cdot H_2O$ was studied using a Mo source. The crystal structure belongs to the $P_a 2_1 a - C_{2b}^4$ rhombic spatial group with lattice parameters a = 11.906, b = 6.884, c = 14.171 Å and N = 4. Atomic coordinates of the compound are tabulated and analyzed. (R.V.J.)

20781 ION COMPENSATION OF A SPACE CHARGE OF RELATIVISTIC ELECTRON FLUXES. V. P. Ignatenko (Moscow Inst. of Mechanics). Zh. Tekhn. Fiz., 32: 1428-32(Dec. 1962). (In Russian)

Dispersion of intense electron flux in a system of plane-parallel electrodes with unlimited emission was investigated. It is assumed that the anode is under high pressure and is an emitter of positive ions. The relation between the electron current increase coefficient in the positive ion function and the anode intensity magnitude was determined. (tr-auth)

20782 THE MODELING OF INTENSIVE ION BEAM FOCUSING. V. P. Ignatenko (Moscow Inst. of Mechanical Engineering). Zh. Tekhn. Fiz., 32: 1433-7(Dec. 1962). (In Russian)

A modeling device with electroconducting paper was used in an investigation of intense ion beam focusing in multielectrode systems. Diagrams of active and passive ion beam focusing are included. (R.V.J.)

20783 THE INFLUENCE OF THE ELECTRON CESIUM PLASMA ON CHARACTERISTICS OF A THERMOELECTRON TRANSFORMER. N. D. Morgulis and Yu. P. Korchevoii (Kiev State Univ.). Zh. Tekhn. Fiz., 32: 1487-9(Dec. 1962). (In Russian)

A special transformer cell with independent arc discharge and incandescent tungsten cathode was introduced into an intra-electrode cesium plasma in order to eliminate the interference of the plasma with cell performance. (R.V.J.)

20784 ON NURINGER'S ERROR. I. I. Shahnov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 32: 1495-6(Dec. 1962). (In Russian)

A correction is suggested for the variable maximum efficiency problem in D. L. Nuringer's article on the theory of magnetohydrodynamic generators. (R.V.J.)

20785 CALCULATION OF RADIAL DISTRIBUTION OF TEMPERATURE IN A CARBON ARC STABILIZED WITH SODIUM. L. A. Spektorov and V. S. Engelsht (Kargiz State Univ., Frunze, USSR). Zh. Tekhn. Fiz., 33: 221-2(Feb. 1963). (In Russian)

The radial temperature distribution of sodium-stabilized d-c carbon arcs (I = 4 amp, 4 mm interelectrode distance) was measured. Good agreement between calculated and experimental magnitudes was observed at distances to 4.5 mm from the axis. (R.V.J.)

20786 ON THE OSCILLATING RELAXATION BEHIND THE SHOCK WAVE. Hang-Ling Pao and Yu. P. Lunkin (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 234-43(Feb. 1963). (In Russian)

An approximation expression was developed for oscillation relaxation behind a plane shock wave. The results are in good agreement with precise numerical calculations. It is shown that with increasing Mach numbers the width of the relaxation width is contracted. (R.V.J.)

20787 DIFFRACTION OF ELECTROMAGNETIC WAVES BY TWO NON-PARALLELED IDEALLY CONDUCTING PLATES. I. P. Skalskaya (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 248-51(Feb. 1963). (In Russian)

Diffraction of plane electromagnetic waves by thin, ideally conducting, non-intersecting plates placed at a given angle α to each other was resolved for cases in which $\alpha = 0$ (parallel plates) and $\alpha = (\pi/2)$ (plane screen with a slit). (R.V.J.)

20788 ON THE THEORY OF FLUCTUATIONS IN MAGNETOHYDRODYNAMICS. I. V. Ioffe (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 253-5(Feb. 1963). (In Russian)

A theory of conducting fluid fluctuations in an external magnetic field was constructed that is analogous to the theory for hydrodynamic fluctuations. (R.V.J.)

20789 OPTICAL TRANSITION PROBABILITIES. A Representative Collection of Russian Articles, 1924-1960. I. Meroz, ed. Translated from Russian by R. N. Sen, O. Ronen, and Z. Lerman. 476p. (OTS 61-11437; PST Cat. 501). $4.75(OTS).

Forty-five articles dealing with anomalous dispersion in various elements, calculation of optical transition probabilities, optical transition probabilities for various elements, absolute and relative transition probabilities, determination of oscillator strengths, oscillator strengths for lines of various elements, f- and gf-values for lines of various elements, and other associated topics are presented chronologically for the period 1924–1960. 765 references. (D.C.W.)

20790 INTERACTION OF ELECTRONS AND NUCLEI IN LITHIUM METAL. Robert Joseph Pressley. Thesis, Princeton, N. J., Princeton Univ., 1962. 152p.

The interaction of the electron spin resonance and the nuclear magnetic resonance in lithium metal is investigated over a temperature range of from 1.4 to 350° Kelvin at a magnetic field of 3400 oersteds. The theory of electron resonance asymmetries and shifts and nuclear resonance shifts due to these interactions is expanded and discussed. An experimental method of producing pure particles of lithium metal of about 5- to 10-micron diameter dispersed in an inert oil by dissolving Li in liquid ammonia is discussed, and the design and construction of the dual microwave r-f spectrometer and a magnet field stabilization control is included. An Overhauser enhancement of over 500 is obtained at room temperature in these samples while skin depth problems prevented attaining any polarization at 1.4°K. The Knight shift in the nuclear resonances is shown to be mainly due to electron polarization and the "g" value of the conduction electrons in lithium metal is found to be less than that of the free electron by 1 part in 10^5. (Dissertation Abstr. XXIII, No. 8)

20791 AN EXPERIMENTAL STUDY OF THE INTERACTION OF PLASMONS AND FAST ELECTRONS IN METALS. Harry Jack Watson. Thesis, Gainesville, Fla., Univ. of Florida, 1962. 64p.

The characteristic energy losses observed when a beam of energetic electrons pass through a thin film of metal have been studied by using the retarded potential method of energy analysis. Good energy analysis was possible with an energy analyzer whose resolution was 0.7 volts. Films of aluminum, magnesium, indium, antimony, tin, lead, titanium, and vanadium ranging in thickness up to 3000 Å have been bombarded by electrons with energies from 15 to 40 kev and the energy loss spectrum observed. The spectra for aluminum, magnesium, antimony, tin, and indium appear in multiples of an energy approximately equal to the free electron plasmon energy while the spectrum of the other metals shows no such regular pattern. The mean free path and cross section for plasmon production have been determined and compared with the Bohm and Pines theory. Good agreement was found for aluminum and magnesium. These quantities, cross section and mean free path, were found to be independent of film thickness but did have the predicted dependence of incident electron energy. When the energy loss spectrum is studied, an asymmetry of the energy loss peaks can be noticed, the most pronounced being in aluminum. When this asymmetric shape is compared to the shape that is obtained for the probability that a fast electron produces a plasmon, are found to be the same for aluminum, magnesium, tin, antimony, and indium. Some similarity also exists for lead. This agreement adds to the evidence that the energy losses are the result of an excitation of the collective plasma in the metal. (Dissertation Abstr. XXIII, No. 8)

20792 THE ORIENTATION OF ELECTRODYNAMICALLY CONTAINED He^4 IONS. Fouad George Major. Thesis, Seattle, Univ. of Washington, 1962. 118p.

Following the discussion of preliminary experiments on the transfer of electron spin orientation between optically pumped alkali atoms and the products of a discharge in hydrogen and helium at low pressures, work is described on the orientation of $(He^4)^+$ ions contained electrodynamically in an r-f quadrupole field by spin dependent scattering from polarized Cs atoms passing through the trapping region in the form of a beam. The He ions were created by a pulsed electron beam which ionized the residual gas (consisting mainly of He introduced through a quartz leak) present in a sealed off glass system. The resonant r-f absorption signal occurring at the axial oscillation frequency of the ions was used to monitor the number of trapped ions. By varying the time interval between the creation of the ions and their detection, their mean lifetime was determined to be about 8 sec for a background pressure of about 3×10^{-6} mm Hg. Since the ions may be lost either by randomizing elastic collisions with the background atoms, or by charge capture from these atoms, it is expected that if these collision processes are dependent on the spin state of the colliding particles, the remaining ions will not only acquire an electron spin orientation (if the atoms are so oriented) but also their number will be a function of their polarization. Thus expressions are given for the polarization of the ions and their number as a function of the time. In order to demonstrate the polarization of the ions, they were created and detected periodically with a frequency of 1 c/sec with the Cs atom polarization being modulated at half that frequency by means of a frequency modulated H_1 field. Similar work on the $(He^3)^+$ ion is proposed with a view to studying the $\Delta F = \pm 1$ hyperfine transitions. (A.G.W.)

20793 THE EFFECTS OF ELECTRIC FIELDS ON THE FLOW OF LIQUID HELIUM. Walter Jim Neidhardt. Thesis, Hoboken, N. J., Stevens Inst. of Tech., 1962. 148p.

An investigation has been made of the effect of electric fields on the flow of liquid helium in a narrow channel superleak whose exit was maintained at a pressure far below the vapor pressure of the liquid. Liquid helium evaporation in the channel and the resulting liquid–gas interface caused an electric pressure gradient. It was found that: (1) Electric fields of magnitude 3×10^6 volts/cm did not destroy the superfluidity exhibited in the channel. A shift in the λ point caused by a field of 1.5×10^6 volts/cm must be less than 0.01°K. A shift smaller than this was not susceptible to observation. (2) The effect of the applied electric field was to increase flow above and below the λ point. (3) At very high applied field the flow attained a limiting value which was a function of temperature. (A.G.W.)

20794 SPIN DIFFUSION AND OTHER TRANSPORT PROPERTIES OF LIQUID He^3. Daniel Warren Hone. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 108p.

The Landau theory of a Fermi liquid is described and discussed, and the transport equation of the theory is used to obtain an expression for the coefficient of self-diffusion D in liquid He^3. It is found that $D = A/T^2$, with $A \approx 4.2 \times 10^{-6}$ cm^2 sec^{-1} degrees^2; T is the temperature in degrees Kelvin. This is within the estimated probable error of the experimental result: $A = 1.54 \times 10^{-6}$ cm^2 sec^{-1} degrees^2. However, the Landau theory is valid only under certain restricted conditions. The formal properties of the exact solution are investigated by a consideration of the thermodynamic Green's functions of the system. The transport coefficients can be expressed in terms of these Green's functions, and such an expression is derived for the coefficient of self-diffusion D. The Landau theory result for D is shown to correspond to the Hartree Fock approximation plus the assumption of a constant lifetime for the quasi-particles of the system. The relationship between D and the dynamic magnetic susceptibility $\chi(k,\omega)$ is demonstrated. The random phase approximation, suitably modified to take account of the hard cores, is shown to give again the Landau result. Finally, the example of the T-matrix approximation is given as a means of determining the value of the constant quasi-particle lifetime at the Fermi surface. It is concluded that the Landau theory gives excellent results for the transport properties of liquid He^3; it is extremely difficult to investigate corrections to it in or near the region where the theory is valid. (A.G.W.)

20795 ON THE STRUCTURE OF SHOCK WAVES IN MONATOMIC GASES. Sridhar Mahadevasastry Ramachandra. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 78p.

The structure of plane, steady shock waves in a neutral monatomic gas was studied using the Boltzmann equation of the kinetic theory of gases and considering the molecules to be rigid elastic spheres. Two collision models are considered: In one model the postulate of a Maxwellian distribution of the lateral components of the molecular velocity is used and the kinetic model of Krook is applied to the resulting collision integral thus reducing the Boltzmann equation to a linear form in the longitudinal velocity distribution function for which the corresponding transport equations are also derived. The second model uses the Boltzmann equation and the associated equations of transfer. As in the original Krook kinetic model, conservation of particle number, momentum, and energy are also ensured at each collision for the present modified kinetic model. A number of parameterized gas models of both types have been constructed, and equations governing these parameters have been obtained by using the method of moments. (A.G.W.)

20796 THE CORRESPONDENCE PRINCIPLE. [PART] I. Izuru Fujiwara. Preprint No. 3. 32p.

Paper from Proceedings of the Physics Seminary in Trondheim, 1962.

Functional integral methods are given for both the particle and field aspects of quantum mechanics. (C.E.S.)

20797 GAMMA-RAYS OF RADIONUCLIDES IN ORDER OF INCREASING ENERGY. D. N. Slater. Washington, D. C., Butterworths Inc., 1962. 209p. $9.00

A list is presented of the energies of γ rays emitted by radionuclides, arranged in order of increasing magnitude. Properties of each nuclide are included. The compilation was prepared to assist in the identification and elucidation of γ scintillation spectra. (C.H.)

20798 THE QUANTUM THEORY OF MANY-PARTICLE SYSTEMS. Harry L. Morrison, ed. International Science Review Series, Volume II. New York, Gordon and Breach Science Publishers, 1963. 359p. $4.95.

Among the topics covered are perturbation theory, adaptation of graphical techniques to perturbation theory, the hard sphere boson system, Green function methods, Feynman's method, zero and non-zero temperature cases of the boson system, Green's function technique in fermion systems, and an attempt to treat many-particle systems from a unified nonperturbative point of view. Other related subjects are also discussed. (D.C.W.)

20799 COLD CATHODE DISCHARGE TUBES. J. R. Acton and J. D. Swift, eds. New York, Academic Press Inc., Publishers, 1963. 356p. $12.00.

An attempt is made to link theory of cold cathode tubes to their design. Theory of the fundamental processes of electric discharges in gases is discussed prior to application of the theory to tube design. References (172) to material on electrical discharges in gases are included. (D.C.W.)

20800 METHOD OF PRODUCING STRAIGHT BEAMS OF SUBSTANCE WITHIN AN ENCLOSED SPACE AT A HIGH VACUUM. (to European Atomic Energy Community). British Patent 923,332. Apr. 10, 1963. Priority date Jan. 21, 1961, Italy.

A method is given for producing in a vacuum a thin beam of density $>10^{-10}$ g/cc of substance which is gaseous at ambient temperature. In this method, a controlled condensation of the substance is effected in a reservoir, and, when the drops are large enough, the gas-drop mixture is injected towards the vacuum under such conditions that the stream of drops is separated from the gas and is then introduced into the vacuum. An example of the method is described in which the gaseous substance is hydrogen and tritium is used to induce condensation. (D.L.C.)

20801 ION SOURCE (R. F. INDUCTION TYPE). C. B. Mills (to U. S. Atomic Energy Commission). U. S. Patent 3,084,281. Apr. 2, 1963.

A method is given for producing energetic ions by ionizing a gas with an oscillating electric field which is parallel to a confining magnetic field, then reorienting the fields perpendicular to each other to accelerate the ions to higher energies. An ion source is described wherein a secondary coil threads the bottom of a rectangular ionization chamber and induces an oscillating field parallel to a fixed intense magnetic field through the chamber. (AEC)

Astrophysics and Cosmology

20802 (AID-Report-62-87) PHYSICAL PROPERTIES OF PLANETARY ATMOSPHERES. REVIEW OF SOVIET LITERATURE. (Library of Congress, Aerospace Information Div., Washington, D. C.). June 30, 1962. 68p. (AD-281871)

Soviet theoretical studies of the physical properties of planetary atmospheres are reviewed. Literature dating from 1951 on the composition, energy sources, dynamics, and optical properties of planetary atmospheres was utilized. 23 references. (D.W.C.)

20803 (JPRS-18605) NEUTRINO ASTRONOMY. Gyorgy Marx. Translated from Fiz. Szemle, 13: No. 1, 13-20(Jan. 1963). 17p. (OTS-63-21534)

The detectibility, nature, and origin of neutrino radiation are discussed; and the possibility of studying stars, sun, and supernovas by their neutrino emission is examined. Searching for antimatter in the universe by its characteristic antineutrino emission is also considered. (D.C.W.)

20804 EXPLORER 12 OBSERVATIONS OF THE MAGNETOSPHERIC BOUNDARY AND THE ASSOCIATED SOLAR PLASMA ON SEPTEMBER 13, 1961. J. W. Freeman (Univ. of Iowa, Iowa City), J. A. Van Allen, and L. J. Cahill. J. Geophys. Res., 68: 2121-30(Apr. 15, 1963).

Phenomena at and near the boundary of the magnetosphere during the prolonged initial phase of a mild magnetic storm on September 13, 1961, were observed with a variety of magnetic field and particle detectors in Explorer 12. There was an abrupt termination of the regular geomagnetic field and a coincident discontinuity in the intensity of trapped particles at a geocentric radial distance of 8.2 earth radii. A mean directional energy flux of the order of tens of ergs $(cm^2\ sec\ ster)^{-1}$ was observed outside the boundary. This energy flux is interpreted as being due to an omnidirectional intensity of the order of 10^{10} $(cm^2\ sec)^{-1}$ of electrons having energies of a few kev. From the Chapman-Ferraro point of view, these electrons are believed to be the observable component of a 'piston' of quasi-thermalized plasma, of the order of 10,000 km thick, which acted as the pressure-transmitting agent between the directional solar wind and the geomagnetic field. Possible relationships between these observations and the 'third radiation belt' of Gringauz are considered. 29 references. (auth)

20805 DECAMETER RADIATION FROM JUPITER. J. L. Hirshfield (Yale Univ., New Haven) and G. Bekefi. Nature, 198: 20-2(Apr. 6, 1963).

The observed correlation between solar flare activity and intense radio bursts from Jupiter in the 5 to 38 Mc/s region was examined as to the origins of this radiation. It is suggested that the radioactivity is brought on by sudden eruptions of fast solar electrons as they arrive at Jupiter, and that an existing theory for maser-like amplification of synchrotron radiation from electrons with a non-Maxwellian energy distribution orbiting in the Jovian magnetosphere provides a quantitative model for the emission. The theory predicts a narrow frequency band of amplification near the local electron gyro-frequency, but the intensity predicted for the second and higher harmonics is smaller than that of the fundamental by more than four orders of magnitude. It is concluded that the appearance of a single band of radiation should not rule out the synchrotron mechanism. (C.H.)

20806 EXCITATION OF FIELD ALIGNED SOUND WAVES BY ELECTRON STREAMS. O. Buneman (Stanford Univ., Calif.). Phys. Rev. Letters, 10: 285-7(Apr. 1, 1963).

Excitation of sound by streaming electrons in the ionosphere is analogous to phonon excitation by Hall currents, but the dynamics and coupling are somewhat different. The coupling is provided by ions that communicate with the neutral gas by collisions and with the electrons by macroscopic electrostatic fields. The sharp dependence of electron mobility on angle, near the 90° inclination to the magnetic field, provides a necessary tunability of the electronic generator to the acoustic load. The wave fronts are field aligned, because the electrons can short out all electric fields. (C.E.S.)

20807 QUANTUM NATURE OF GRAVITONS IN AN EXPANDING UNIVERSE. Hidekazu Nariai and Toshiei Kimura (Hiroshima Univ.). Progr. Theoret. Phys. (Kyoto), 28: 1104-5(Dec. 1962). (In English)

An attempt to reconcile the concept of gravitons with the hypothesis of the expanding universe is presented. The four-dimensional commutation function and the propagation function for gravitons are studied. It is suggested that the concept of gravitons can not be compatible with the hypothesis of the expanding universe based on the general theory of relativity. (C.E.S.)

20808 THE SUN AS A SOURCE OF INTERPLANETARY GAS. C. De Jager (Sterrewacht "Sonnenborgh", Utrecht). Space Sci. Revs., 1: 487-521(Mar. 1963). (In English)

The sun is considered as a source of gas that is continuously emitted into all directions but mainly in the equatorial plane. A discussion of the quasi-stationary streams emerging from the solar activity regions and the flare-associated bursts of particles of greatly varying densities and velocities is presented. (C.E.S.)

20809 INTERPLANETARY PLASMA. R. Luest (California Inst. of Tech., Pasadena). Space Sci. Revs., 1: 522-52(Mar. 1963). (In English)

Evidence for an interplanetary plasma is given. Assumptions are made to get quantitative data about relevant parameters of the interplanetary medium. Theoretical models describing the state of the interplanetary plasma are described. (C.E.S.)

20810 REMARKS ON THE LIMITATION OF OPTICAL METHODS FOR MEASURING ELECTRON DENSITIES IN THE CORONIA AND INTERPLANETARY SPACE. D. E. Blackwell (Oxford Univ.). Space Sci. Revs., 1: 612-14 (Mar. 1963). (In English)

The difficulties of electron density measurements in the corona increase with increasing distance from the sun because some of the light of the corona is due to scattering by interplanetary dust, and a separation of the dust and electron scattering components must be made before electron densities can be deduced. Two methods of separating these components are described and their limitations discussed. The methods are also applied to interplanetary space. (C.E.S.)

20811 ON THE LUMINESCENCE OF THE ENVELOPE OF NOVA BY THE SHOCK WAVE FRONT. V. G. Gorbatskii. Vestn. Leningr. Univ., No. 19, Ser. Mat. Mekh. i Astron. No. 4, 112-23(1962). (In Russian)

The radiation of the envelope of Nova heated by a shock wave is investigated. The time dependence of gas temperature is derived on the assumption that the pressure (p) is the same at all points behind the shock wave front. The energy loss by gas, which is dependent on temperature and chemical composition of the medium, is calculated. The differences between the standard cooling law of gas and the one derived on the assumption that grad p = 0 are considered. It is found that these differences do not affect the earlier conclusions concerning the interaction of the envelope of nova with the corpuscular stream ejected by star. (auth)

20812 PHYSICAL PROCESSES IN STELLAR INTERIORS. (Fizicheskie Protsessy Vnutri Zvezd). D. A. Frank-Kamenetskii. Translated from Russian, 1962. 347p. (NASA TT F-124; IPST-Cat.-815). $3.50(OTS)

Modern atomic and nuclear physics are used to describe the processes in stellar interiors. Fundamental methods are used for calculating physical processes taking place at temperatures of millions of degrees. The theory of stationary processes, applications of the theory of stationary processes, and the theory of non-stationary processes are considered. (C.E.S.)

Cosmic Radiation

20813 (AD-284488) TIME PATTERN OF IONIZING RADIATION IN BALLOON ALTITUDES IN HIGH LATITUDES. Final Report. Georg Pfotzer, Alfred Ehmert, and Erhard Keppler (Max-Planck-Institut für Aeronomie. Institut für Stratosphärenphysik, Lindau/Harz, Germany). Aug. 1, 1962. Contract AF61(052)-372. 53p.

This report is Part A, Text. For Part B, Figures and Diagrams, see AD-284490.

A series of 23 successful unmanned balloon flights to measure the cosmic radiation, solar protons, and x rays at high altitudes in the auroral zone (Kiruna/Sweden) was carried out. The equipment and the special viewpoints of the measurements are described in detail, and the results are compiled in 45 diagrams. In addition to x ray events which occur relatively frequently in the auroral zone, four cases of solar proton injections occurring on July 12th, 18th, 20th, and 27th, 1961, were recorded during the passage of two very active plage regions across the solar disk. The various events are briefly discussed. The measurements are counterparts of similar ones carried out simultaneously by American groups. (auth)

20814 (AFCRL-62-442) SOLAR WIND INTERACTIONS. Final Report. A. J. Dessler (Lockheed Missiles & Space Co., Palo Alto, Calif.). Apr. 14, 1962. Contract AF19(064)-7989. 75p. (AD-281749)

Eleven journal publications on effects of solar wind on magnetosphere, shape of geomagnetic field in solar wind, and interplanetary effects are presented. Topics covered include: formation of the geomagnetic storm main-phase ring current; some effects of diamagnetic ring currents on

Van Allen radiation; stability of interface between the solar wind and the geomagnetic field; possible energy source for the aurora; hydromagnetic emissions, x-ray bursts, and electron bunches; gross character of the geomagnetic field in the solar wind; interaction of the terrestrial field with solar corpuscular radiation; diurnal variation of cosmic radiation intensity produced by a solar wind; and termination of solar wind and co-rotation of solar magnetic field. (M.C.G.)

20815 (BNL-779) THE HISTORY OF COSMIC RAYS AND METEORITES. Oliver A. Schaeffer (Brookhaven National Lab., Upton, N. Y.). June 14, 1961. Contract [AT(30-2)-Gen-16]. 12p. (BNL-T-295)

Brookhaven Lecture Series No. 8.

The nature and origin of meteorites are discussed; and techniques used in determining the age and the exposure times of meteorites by analysis of cosmic ray reactions within them are described. Similarly, meteorite analysis as a means of determining cosmic ray constancy and distribution is examined. Study of cosmic radiation with satellites is briefly treated. (D.C.W.)

20816 SOUNDING OF ELECTROMAGNETIC CONDITIONS BY HIGH ENERGY COSMIC RAYS IN INTERPLANETARY SPACE AND IN THE VICINITY OF EARTH. L. L. Dorman, A. I. Kuz'man, and G. V. Skripin. (Translated by Andre L. Brichant from Geomagnetism i Aeronomiia, 1: 333-45(1961)).

On the basis of continuous data registration of cosmic ray intensity on the ground at Yakutsk (by means of neutron monitor, ionization chamber, and counter telescope) and also underground (by means of counter telescopes at vertical, south, and north directions at 7, 20, and 60 mwe), time variations of cosmic rays of various types are investigated: magnetic storm effects, solar-diurnal effects, and 27-day, seasonal, and 11-year variations. The energy spectrum of the primary variations is determined, and the possible causes are considered in connection with electromagnetic conditions in the vicinity of the earth, in solar corpuscular streams, and in interplanetary space. (auth)

20817 THE TIME VARIATIONS OF SOLAR COSMIC RAYS DURING THE SEPTEMBER 3, 1960, EVENT. J. R. Winckler and P. D. Bhavsar (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 68: 2099-2115(Apr. 15, 1963).

The results of a series of high-altitude measurements on 17 balloon flights at Fort Churchill, Manitoba, Canada, and Minneapolis, Minnesota, during the flare event of September 3, 1960, are described. This flare is unique in that it is the only one during the solar cycle in which an east-limb event produced both a sea-level and a high-altitude increase in cosmic ray detectors. Detailed investigation of the radio emission identifies this flare as the most probable source of the cosmic ray particles. An x-ray burst observed during the flare is shown to be the result of a geomagnetic disturbance and not to have come directly from the solar surface. The particle onset measured by balloons at high latitude was 83 minutes after the microwave burst associated with flare maximum. The increase of intensity during the first five hours of the event can be fitted well by a diffusion model in interplanetary space with a point source in an infinite diffusing medium. The diffusion analysis shows that the interplanetary main free path on the average is 0.02 astronomical unit. Several interplanetary geomagnetic disturbances, however, distorted the particle increase before maximum intensity was observed. The decay of the event followed an exponential relationship for 140 hours after the flare, with a relaxation time of 23 hours It is shown that this is consistent with the presence of a barrier at about two astronomical units from which particles escape at infinity and do not return inward. Very complex variations of intensity were observed at Minneapolis during the geomagnetic storm associated with cutoff changes for the incident solar particles in the geomagnetic field. These cutoff changes are well correlated with the main phase equatorial field fluctuations observed. A frequency power spectrum analysis of these time variations shows the presence of an eight-minute period and also longer periods, particularly thirty minutes. The energy spectrum of this event is very flat, which accounts for the particles being observable at sea level even though the high-altitude intensity was not as high as many other events. The spectrum may be well represented by an exponential rigidity for the integral particle flux, and values for the constants are given here. All the balloon data are presented as rate time charts at both the latitudes at which measurements were made. 21 references. (auth)

20818 SIMULTANEOUS BALLOON OBSERVATIONS AT FORT CHURCHILL AND MINNEAPOLIS DURING THE SOLAR COSMIC RAY EVENTS OF JULY 1961. David J. Hofmann and John R. Winckler (Univ. of Minnesota, Minneapolis). J. Geophys. Res., 68: 2067-98(Apr. 15, 1963).

The solar cosmic ray events of the period July 12-20, 1961, were studied with many simultaneous balloon flights at Fort Churchill, Manitoba, Canada, and Minneapolis and Bemidji, Minnesota. During the low-energy solar cosmic ray event on July 12-13, γ rays were detected that were produced as the result of nuclear reactions of the solar cosmic rays with air nuclei. The balloon results were correlated with the Injun 1 results, which showed protons in the range 1 to 15 Mev that could not reach the balloons but that produced the observed γ rays. The observed proton γ-ray correlation agrees well with theoretical calculations of cross sections, and the proton flux between infrequent passes over northern latitudes of Injun 1 was reconstructed. This γ-ray inferred time history of the event indicated a gradual increase in proton intensity from about 18 hours before the July 13 sudden commencement until shortly thereafter. Then the fluxes dropped sharply, possibly because of an increased geomagnetic cutoff rigidity at Fort Churchill during the initial phase of the magnetic storm, and showed much time structure during the main phase of the storm. In addition to the γ rays, low-energy x rays were observed coincident with the sudden commencement. These x rays are probably due to electron precipitation, as observed in earlier events. The further events on July 18-20 were studied in their entirety by means of balloons floating at high altitude at Fort Churchill and Minneapolis. Since the complete time history of the solar cosmic rays was obtained, it has been possible to study the mechanisms responsible for the increase and the decay phase of these events. The intensity increase through the time of maximum for particles in a fixed energy region was found to be well described by the point source infinite medium diffusion equations in interplanetary space. The decay phase, exponential in character, requires the assumption of an escape barrier located at about two astronomical units from the sun. The diffusion mean free path was found to be between 0.025 and 0.04 AU. From diffusion theory, assuming uniform emission from the point source, the number of particles emitted into unit solid angle was found to be about 10^{32} particles/cm^2 sec ster for the event on July 18 and about an order of magnitude lower for the smaller event on July 20. In addition, the time of ejection of the solar particles from the sun in finding the best fit to diffusion theory was estimated. In these events, the simultaneous flights at different latitudes also enabled us once more to study the

geomagnetic cutoff changes associated with the magnetic storm periods. The decrease in cutoff was found to correlate well with negative excursions of the equatorial magnetic field, and, because the particle spectrums were known, the cutoffs at Minneapolis could be estimated. 37 references. (auth)

20819 THE MOST ENERGETIC PARTICLE YET DISCOVERED. Peter Stubbs. New Scientist, 17: 622-3 (Mar. 21, 1963).

A huge shower of cosmic ray particles was detected that was caused by a single particle with an estimated energy of 10^{20} ev striking the earth's atmosphere. Very energetic particles may give clues about the origins of cosmic rays. (auth)

20820 CHARACTERISTICS OF FORBUSH DECREASES IN COSMIC RAY INTENSITY OBSERVED UNDERGROUND. T. Mathews (Imperial Coll. of Science and Tech., London). Phil. Mag. (8), 8: 387-400(Mar. 1963).

Characteristics of Forbush decreases in cosmic-ray intensity recorded underground at 60 m.w.e. during November 1960 and July 1961 are described. These decreases are compared with those recorded during the same period at sea level, as well as with those recorded at other underground stations. It is shown that, following the decreases of November 1960, large anisotropies existed in primary cosmic-ray intensity which could be detected even by monitors situated deep underground. The observed decreases are compared with the predictions of different theories that have been proposed to account for Forbush decreases. (auth)

20821 AZIMUTHAL SYMMETRY IN THE SHOWER PARTICLES OF 24 Gev PROTON JETS. G. K. Rao and A. A. Kamal (Osmania Univ., Hyderabad, India). Proc. Phys. Soc. (London), 81: 190-1(Jan. 1, 1963).

Azimuthal asymmetry in the shower particles produced in 24 Bev proton interactions was investigated, using an emulsion technique, with a view to checking the predictions of the excited-center models. The azimuth angles were plotted and a χ^2 test applied to detect possible asymmetry. It is found that the distribution is actually consistent with isotropy. (auth)

20822 REVIEW OF STUDIES OF TRAPPED RADIATION WITH SATELLITE-BORNE APPARATUS. B. J. O'Brien (Univ. of Iowa, Iowa City). Space Sci. Revs., 1: 415-84(Mar. 1963). (In English)

A comprehensive set of references and very brief descriptions of experiments that have studied the radiation zones are provided. A review of some measurements that have been misinterpreted is provided for theoreticians. The modification of the radiation zones by the production of the durable artificial radiation belt adds importance to the review since measurements on the natural inner zone are now impossible. (C.E.S.)

20823 INVESTIGATION OF THE DIURNAL PERIOD OF COSMIC RADIATION. W. Messerschmidt (Deutsche Akademie der Wissenschaften, Berlin and Universität, Halle/Saale, Ger.). Z. Naturforsch., 18a: 66-78(Jan. 1963). (In German)

The Halle installation for registration of cosmic radiation consists of 4 ionization chambers in different arrangements. The material of 6 years preceding August 1960 was from a neutron monitor operated according to Simpson. In addition the registrations from Lindau (Harz) and Kiel were consulted. The following problems relative to the diurnal period for the individual arrangements were investigated: the pattern in a single year, the seasonal dependence, the phase length and the phase constant, the 27-day period, the explanation of the curve form, the world-wide character, and the sidereal time period. (tr-auth)

20824 A MEASUREMENT OF THE MOMENTUM LOSS OF ENERGETIC COSMIC RAY MUONS IN A THICK PLATE. Stanley Bartlett Curtis. Seattle, Univ. of Washington, 1962. 134p.

An eleven-inch lead target separates two sections of a Wilson cloud chamber immersed in a magnetic field of 11,000 gauss. The magnetic deflections of cosmic-ray particles emerging unaccompanied from a 26-inch lead shield above the chamber were measured before and after traversal of the lead target. In the first half of the experiment, two proportional counters buried half-way through and immediately below the target allowed any minimum ionizing particle traversing a three-fold counter telescope to trigger the chamber. From a statistical analysis of 291 events, it is found that the muon ionization process accounts for the momentum loss of particles in the 1- to 20-Bev energy region. In the second half of the experiment, the two proportional counters were biased so as to trigger the chamber only when a large pulse (equivalent to 8–10 minimum ionizing particles) appeared in either proportional counter. This requirement selected 2% of the incident muons. An analysis of 312 events shows that the momentum losses are shifted to larger values. In the 1- to 4-Bev incident energy region, it is shown that particles lose momentum consistent with that expected from the collision and bremsstrahlung processes. The positive excess, η (defined as the difference between the number of positive and negative incident particles divided by their sum), of both these groups is consistent with that obtained by other workers, but the η of those events obtained with the counters biased and, in addition, where an electromagnetic shower appears below the target, is anomalously high: 0.49 ± 0.12. If the incident particles are muons, this constitutes possible evidence for a charge dependence of either the muon-electron or muon bremsstrahlung cross section at large momentum transfers. (A.G.W.)

Criticality Studies

20825 (HW-75319) NUCLEAR SAFETY PARAMETERS FOR 0.5-IN. DIAMETER, 1.8 W/O Pu–Al ALLOY RODS IN LIGHT WATER. C. L. Brown (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 29, 1962. Contract AT(45-1)-1350. 15p.

The buckling values for 0.5-in.-dia, 1.8 wt % Pu–Al alloy rods in light water, reported in HW-74190, were used to estimate the critical parameters for water-moderated and -reflected arrays of these elements. The values obtained are: minimum critical mass, 2.28 kg Pu; minimum critical volume, 445.4 liters; minimum critical slab thickness, 9.3 in.; minimum critical cylinder diameter, 17.6 in.; and minimum critical mass/unit area, 41.8 lbs of alloy/ft^2. The maximum material buckling obtained from the measurements was 0.006130 cm^{-2} at a water-to-alloy volume ratio of 1.55. The minimum critical mass occurs at a water-to-alloy volume ratio of 2.0. The above values will be used as the basis for nuclear safety evaluations concerning the handling and storage of these fuel rods. (auth)

20826 (UCRL-7262) COUPLING EFFECTS OF HAFNIUM CONTROL RODS IN A NEAR-HOMOGENEOUS, BeO-MODERATED, ORALLOY-FUELED SYSTEM. J. M. Piowaty, John R. Morton, III, and Loren L. Gardner

(California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 27, 1963. Contract W-7405-eng-48. 10p.

Two series of measurements were made to examine the coupling effects of Hf control rods. From two to five rods were used. The measurements were performed on a BeO-moderated, U^{235}-fueled system with a BeO/U^{235} molar ratio of 247. The pulsed neutron technique was used. (auth)

20827 CRITICALITY OF INTERACTING ARRAYS OF FISSILE MATERIAL. I. GENERAL THEORY. D. C. Dowson (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Nucl. Energy, Pt. A & B, 17: 1-6(Jan. 1963). (AHSB(S)R-28). (In English)

A criterion is described for testing whether an array of fissile units is subcritical, critical, or supercritical. A precise meaning is given to the term "degree of criticality." Formulas are derived for the multiplication of an array immersed in a nonabsorbing medium for both external and internal neutron sources. The criterion is shown to apply no matter in what detail the neutron emission is considered. (auth)

20828 CRITICALITY OF INTERACTING ARRAYS OF FISSILE MATERIAL. II. UNREFLECTED AIR-SPACED ARRAYS OF SPHERES. D. C. Dowson and F. Abbey (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). J. Nucl. Energy, Pt. A & B, 17: 7-13(Jan. 1963). (AHSB(S)R-29). (In English)

An initial application of the general method formulated in Part I to some unreflected air-spaced arrays of similar fissile spheres is described. (auth)

Elementary Particles and Radiations

Refer also to abstracts 21110, 21111, 21112, 21114, and 21118.

20829 (ISS-63/11) PROGRAMMA PER IL CALCOLO DELLA CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA INFERIORE ALLA MASSA PROTONICA (CALCOLATORE IBM 610). (Program for Calculating the Kinematics of the Photoproduction from Hydrogen of Particles with a Mass Less than That of the Proton (IBM 610 Electronic Computer)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 21p.

A program was prepared for calculating the angular correlations in the photoproduction from hydrogen of a particle with a mass less than that of the proton. The momentum and the angle of emission in the laboratory system of this particle being fixed, the momentum and the angle of proton in the laboratory system and the energy of the incident quantum are calculated. (auth)

20830 (ISS-63/12) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 300 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 300 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 23p.

Kinematical tables for the photoproduction from protons of a particle of 300 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20831 (ISS-63/13) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 350 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 350 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 20p.

Kinematical tables for the photoproduction from protons of a particle of 350 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20832 (ISS-63/14) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 400 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 400 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 20p.

Kinematical tables for the photoproduction from protons of a particle of 400 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20833 (ISS-63/15) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 450 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 450 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 20p.

Kinematical tables for the photoproduction from protons of a particle of 450 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20834 (ISS-63/16) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 500 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 500 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 28p.

Kinematical tables for the photoproduction from protons of a particle of 500 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20835 (ISS-63/17) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 600 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 600 Mev Effective Mass from Hydrogen (Angular Correlations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 18p.

Kinematical tables for the photoproduction from protons of a particle of 600 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20836 (ISS-63/18) CINEMATICA DELLA FOTOPRODUZIONE IN IDROGENO DI PARTICELLE DI MASSA APPARENTE PARI A 700 Mev (CORRELAZIONI ANGOLARI). (Kinematics of the Photoproduction of Particles of 700 Mev Effective Mass from Hydrogen (Angular Corre-

lations)). G. Campos Venuti and D. Giucci (Italy. Istituto Superiore di Sanità, Rome). Jan. 29, 1963. 16p.

Kinematical tables for the photoproduction from protons of a particle of 700 Mev effective mass were calculated in relation to the angular correlations in the laboratory system using the program described in report ISS 63/11. (auth)

20837 (JINR-D-1202) POLARIZATSIYA PROTONOV OTDACHI PRI RASSEYANII π-MEZONOV S ENERGII 300 Mev NA VADORODE. (Polarization of Recoil Protons in 300 Mev π-Meson Scattering on Hydrogen). I. M. Vasilevskii and V. V. Vishnyakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 5p.

Recoil proton polarization was studied in π meson scattering on hydrogen at 300 Mev. A hodoscope system with 800 Geiger counters was used for measuring elastic π^- and proton scattering on carbon targets at 8 to 30° angles. 777 events of recoil proton scattering were found at 16 to 31° recoil angles. The results were tabulated and compared to published data. (R.V.J.)

20838 (JINR-E-1170) ON INTERACTING FIELDS WITH A DEFINITE SPIN. V. I. Ogievetskii and I. V. Polubarinov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 12p.

The notion of the spin of interacting field is discussed. For the interaction of high spin fields such requirements are stated under which every interacting field transfers a single angular momentum, i.e., it has one definite spin. The corresponding conditions select a certain limited class of interactions. Examples of such theories are given. 21 references. (auth)

20839 (JINR-E-1189) PARTIAL WAVES FOR PION-NUCLEON SCATTERING TAKING INTO ACCOUNT PION-PION INTERACTION. P. S. Isaev, V. I. Lendel, and V. A. Meshcheryakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 12p.

The effect of the π-π interaction in state T = J = 0 on the π-N scattering partial waves is investigated by the method of dispersion relations. In the final expressions a transition to the statical limit is made, and comparison with experimental data is given. The most probable form of the δ_0^0 phase shift of π-π scattering is discussed. Relations are obtained linking the π-π interaction contributions to S and P waves of π-N scattering. On the basis of these relations some works on the π-N scattering are analyzed. Consequences following from the relations are considered for the statical limit. (auth)

20840 (JINR-E-1194) REGGE POLES AND PERTURBATION THEORY. III. A. A. Logunov, Nguyen Van-Hieu, A. N. Tavkhelidze, and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 8p.

The contributions from the cuts in the l-plane to the scattering amplitude are investigated. A way of separating the pole terms is discussed. These terms are the main ones in the expansion in $e^2/\sqrt{E}$. (auth)

20841 (JINR-E-1208) ON ALGEBRAIC PROBLEMS IN THE THEORY OF COMPLEX ANGULAR MOMENTUM. G. Domokos (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 7p.

A method is given for reducing algebraic operations with complex angular momenta (addition, recoupling, etc.) to ordinary angular momentum algebra by expanding the matrix elements $D^j_{mm'}$ (R) for complex j into an orthogonal series. The generalization of vector coupling coefficients and their sum role for complex total angular momenta are treated as examples. (auth)

20842 (JINR-P-1168) OBRAZOVANIE MEZOATOMOV GELIYA V GAZOVOI SMESI VODORODA S GELIEM. (Helium Mesic Atom Production in Gaseous Mixture of Hydrogen with Helium). O. A. Zaimidoroga, M. M. Kulyukin, R. M. Sulyaev, A. I. Filippov, V. M. Tsupko-Sitnikov, and Yu. A. Scherbakov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 12p.

In order to clarify the possibility of carrying out an experiment on μ^- capture in He^3 using small amounts of He mixed with H_2, the process of He mesic atom production in such a mixture was investigated. Use was made of a diffusion chamber filled with mixtures of H_2 and He^4 and H_2 and He^3 with methyl alcohol as operating liquid, the nuclear concentrations of He^4 and He^3 being 4.9 and 14.3%, respectively. It is shown that the determination of the number of stars due to μ^- capture by C, O, and He at two different concentrations of the He together with the use of data on π^- capture in the same mixture make it possible to determine the probability λ_{He} of μ^- transfer to He from the ground state of the H mesic atom. Data on π^- capture, the transfer of which from mesic H is possible only from high levels, allow estimation of the probability of direct H mesic atom production in the mixture. In the experiment with He^3 it was possible to evaluate directly the total probability of He mesic atom production through the yield of the reaction $\mu^- + He^3 \rightarrow H^3 + \nu$ and the reaction rate expected on the basis of the universal weak interaction theory. The value λ_{He} turned out to be $-(1.4 \pm 3.8)\ 10^6$/sec, i.e., it cannot be considerably larger than 10^6/sec, if it is in agreement with the theoretical value. This value is at least 10^3 times smaller than the transfer rate to C and O nuclei which may be found if λ_{He} is known. The experimental data are consistent with the "Z-law" for the atomic capture probability of the mesons in gaseous mixtures H–He and H–CH_3OH. (auth)

20843 (JINR-P-1179) RASCHET INTENSIVNOSTI IZLUCHENIYA VAVILOVA-CHERENKOVA S UCHETOM DISPERSII. (Calculation of Vavilov-Cherenkov Radiation Intensity with Account of Dispersion). V. P. Zrelov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 5p.

It is shown that in calculating the intensity of Vavilov-Cherenkov radiation near the radiation threshold the neglect of the medium dispersion leads to essential errors. Formulas for a correct calculation are given. (auth)

20844 (JINR-P-1188) DEISTVITEL'NAYA CHAST AMPLITUDY UPRUGOGO p-p RASSEYANIYA VPERED. (Real Part of Elastic p-p Forward Scattering Amplitude). L. S. Azhgirei and S. B. Nurushev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 7p.

The real part of the spinless forward p-p scattering amplitude is determined by observing the Coulomb interference in the differential elastic p-p scattering in the energy range of 150-660 Mev. The results obtained are compared with those found from the phase shift analysis and dispersion relations. 20 references. (auth)

20845 (JINR-P-1195) KVAZIPOTENTSIAL'NAYA PRIRODA PREDSTAVLENIYA MANDEL'STAMA. (Quasipotential Character of the Mandelstam Representation). A. A. Logunov, A. N. Tavkhelidze, and O. A. Khrustalev (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 5p.

It is shown that the assumption about the existence of the Mandelstam representation leads to the requirement that the system should be described by a potential that is a superposition of Yukawa potentials with energy dependent intensities. (auth)

20846 (JINR-P-1206) FAZOVYI ANALIZ NUKLON-NUKLONNOGO RASSEYANIYA PRI ENERGII 147 Mev. (Phase Shift Analysis of Nucleon-Nucleon Scattering at 147 Mev). Yu. M. Kazarinov, V. S. Kiselev, and I. N. Silin (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 12p.

New experimental data made previously found phase shifts appear more accurate. The solution is shown to be unique near ±5°. In a considerable number of cases, the values of the phase shifts are different by three or more magnitudes from those found by Breit and from the phase shifts calculated by Hamada-Johnson's potentials. Data are given. 21 references. (auth)

20847 (JINR-P-1207) UPRUGOE np- RASSEYONIE PRI ENERGII 630 Mev. (Elastic n-p Scattering at 630 Mev). Yu. M. Kazarinov, F. Legar, and Yu. N. Simonov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 8p.

The differential cross sections for elastic n-p scattering were measured in the angle region close to 0 and 180° (cms). The coupling constant of the π-N interaction was found to be $f^2 = 0.057 \pm 0.06$. (auth)

20848 (JPL-TR-32-373) LEAST-SQUARE ANALYSIS OF GAMMA-RAY PULSE HEIGHT SPECTRA. J. I. Trombka (California Inst. of Tech., Pasadena. Jet Propulsion Lab.). Dec. 15, 1962. Contract NAS 7-190. 30p.

In this analysis the pulse height spectrum due to a polyenergetic distribution of gamma rays is synthesized by using a series of normalized pulse height distributions resulting from the monoenergetic components in the incident beam. All of these monoenergetic pulse height distributions are weighted so their sum is a best fit, based upon a least-square criterion, to the experimentally determined polyenergetic pulse height distribution. There is difficulty in the application of least-square technique to the analysis of pulse height spectra because the problem is nonlinear in energy. In the technique described here, this difficulty has been overcome by using linear methods of solution, but applying the constraint that only positive or zero values be allowed for the intensities or amplitudes of the various monoenergetic components. The method of solution indicates the energy components and the corresponding amplitudes present in the polyenergetic pulse height spectrum. Error calculations are performed to determine the precision of the solution. Spectra and the Fortran statement of the least-square analysis program are included. (auth)

20849 (NBS-TN-74) SCATTERING OF COBALT-60 GAMMA RADIATION IN AIR DUCTS. Charles Eisenhauer (National Bureau of Standards, Washington, D. C.). [1960]. 24p. (PB-161575)

The exposure dose rates due to cobalt-60 gamma radiation scattered in small air ducts in concrete were measured for ducts with one and two right angle bends. The inside corner of a right angle bend was found to be an important source of scattered radiation. Results are analyzed in terms of solid angle relation, and attempts are made to extrapolate experimental results to other duct configurations. Dose rates vs distance from bends are graphed. (auth)

20850 N–Θ SCATTERING DISPERSION RELATION IN THE LEE MODEL WITH DIPOLE GHOST. K. L. Nagy (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 15: 199-202(1963). (In English)

The N–Θ scattering dispersion is examined in the Lee model in the dipole ghost case. The dipole ghost produces a second order pole in the relation. (auth)

20851 PION DECAY AND THE ANOMALOUS INTERACTION OF MUONS. Chén Shi and G. Marx (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 15: 251-5 (1963). (In English)

Limitations for the anomalous interaction of mesons (μ) due to the branching ratio $(\pi \rightarrow e) : (\pi \rightarrow \mu)$ are discussed to determine the origin of the meson (μ) mass. (C.E.S.)

20852 ASYMPTOTIC PROPERTIES AND ZEROS OF THE FORWARD SCATTERING AMPLITUDE. Józef Namysłowski and Romuald Wit (Jagellonian Univ., Krakow). Acta Phys. Polon., 23: 197-203(Feb. 1963). (In English)

Starting from the well established agreement between the one subtracted ordinary dispersion relation and the experimental data, the diffraction picture for the pion-nucleon forward scattering amplitude at very high energy is presented. It is found that there are two or four zeros lying in the domain of analyticity of the pion-nucleon forward scattering amplitude. (auth)

20853 POSSIBILITY OF OBSERVING THE MAGNETIC CHARGE OF AN ELECTRON. Halstead Harrison, Nicholas A. Krall, O. C. Eldridge, F. Fehsenfeld, Wade L. Fite, and Werner B. Teutsch (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Am. J. Phys., 31: 249-54 (Apr. 1963).

The Lorentz force law and Maxwell's equations are extended to include magnetic as well as electric charges, by requiring that the equations be symmetrical in these charges. This extension predicts that the absolute magnetic charge of a particle cannot be detected. What can be detected are differences in magnetic charge between elementary particles and the validity of the assumed method of extending the Maxwell–Lorentz equations. An experiment is described that appears to measure the magnetic charge of an electron, but which instead bears on the form of the Maxwell–Lorentz equations. Other arguments limit the difference between proton and electron magnetic charges. (auth)

20854 GEOMETRICAL METHOD FOR RELATIVISTIC PARTICLE KINEMATICS. Moon H. Cha and Donald G. Simons (Naval Ordnance Lab., Silver Spring, Md.). Am. J. Phys., 31: 280-2(Apr. 1963).

A geometrical method for solving relativistic particle kinematics is presented. The method is especially useful for obtaining the energy and momentum distributions in a two-particle system, and the threshold energy for particle production. Energy and momentum distributions in a many-particle system are also discussed. (auth)

20855 SELF-STRESS, COVARIANCE AND THE CLASSICAL ELECTRON. Frank R. Tangherlini (Duke Univ., Durham, N. C.). Am. J. Phys., 31: 285-8(Apr. 1963).

It is shown that the covariance problem of the classical electron cannot be divorced from the self-stress problem as claimed recently by Rohrlich. The basic invariance principle of a relativistic field theory (i.e., the formalism should be independent of the choice of the family of space-like hypersurfaces) is used to give another derivation of von Laue's theorem. This new derivation makes it quite clear that the energy-momentum expressions calculated from the Maxwell energy-stress tensor are surface dependent because of the nonvanishing of the self-stress. The fact that the early workers obtained the well-known factor of $\frac{4}{3}$ in the momentum expressions for one choice of surface, and Rohrlich and others find a factor of unity for another choice of surface, merely serves to confirm the violation of the basic invariance principle. Some additional remarks are made about the covariance problem of classi-

cal electrodynamics. The advantages and implications of the alternative proposal of Poincaré are elucidated. (auth)

20856 ON AN ATTEMPT TO REDUCE THE NUMBER OF BASIC CONSTANTS IN ELEMENTARY PARTICLE PHYSICS BY INTRODUCING PSEUDOSCALAR PARAMETERS. PART I. THE MASS SPECTRUM OF FERMIONS. H. Adolf S. Eriksson (Royal Inst. of Tech., Stockholm). Arkiv Fysik, 23: 385-402(1963). (In English)

A complete set of parameters λ_1, λ_2, ϵ_1, and ϵ_2, behaving like ordinary constants under proper Lorentz transformations but having different transformation properties under the wider group of Lorentz transformations that includes also the three kinds of inversion P, T, and PT, is chosen as coefficients of the derivative terms in a generalized Dirac equation and another complete set of parameters q_1, q_2, p_1, and p_2 as coefficients of the mass terms. It is assumed that the parameters are fundamental, i.e., that their values do not change from particle to particle but that they occur differently for the various particles. In other words, not all of the eight parameters occur for a given particle, and the various Dirac particles are classified according to the parameters which do occur. This implies that the number of basic constants is equal to the number of independent ratios between the parameters, which is seven if only the fermions are considered. The conditions for transforming the generalized Dirac equation into an ordinary one give selection rules for the combinations of parameters. In the transformed equation the mass appears as the square root of a ratio of the type $(q_1^2 + q_2^2 + p_1^2 + p_2^2)/(\lambda_1^2 + \lambda_2^2 + \epsilon_1^2 + \epsilon_2^2)$, where the parameters that are absent for the particle in question are to be omitted. If the combinations of parameters for the various particles were known, the experimental values for the masses of seven particles would obviously suffice to calculate the ratios between the parameters, and thus the masses of all remaining particles. Since the number of leptons and baryons so far discovered is ten (if the massless neutrinos are excluded) the number of these remaining particles is three. Consequently the present investigation deals with the question of whether it is possible to find ten allowed combinations of parameters that give satisfactory values for the three least accurately measured masses when the experimental values for the other seven masses are used to calculate the ratios between the parameters. The results obtained are surprisingly good considering the fact that the starting point of the scheme (i.e., the original generalized Dirac equation) seems rather artificial from a physical point of view, at least in the form given here. In the first place, the calculated mass of the Ξ^- hyperon turns out to agree very well with the experimental value. Also, the calculated difference between the masses of the Σ^- and Σ^0 hyperons, and the calculated mass of the Ξ^0 hyperon are consistent with present measurements. Moreover, the scheme appears to provide an explanation of why a given particle is charged or uncharged, for it is proved that electromagnetic terms cannot be introduced into the Dirac equation if certain combinations of parameters occur. A disquieting feature of the scheme is that many undiscovered particles can be obtained from it. (auth)

20857 HEAVY MESONS IN ANTINUCLEON ANNIHILATION. H. Pilkuhn (Univ. of Stockholm). Arkiv Fysik, 23: 411-15(1963). (In English)

Deviations from the statistical theory are expected in the production rates of heavy mesons (ω, ρ, K^* . . .) in antinucleon annihilation, due to residual interactions. These interactions reduce the heavy meson rates at high multiplicities. The effects can be estimated for the ρ meson by means of a classical model. If the η and ζ mesons cannot be coupled to nucleons with Yukawa-type couplings, it is possible that they are not produced in antinucleon annihilations. (auth)

20858 PERTURBATION THEORY OF ANTINUCLEON ANNIHILATION. H. Pilkuhn (Univ. of Stockholm). Arkiv Fysik, 23: 471-7(1963). (In English)

The previous applications of low-energy models to the long-range parts of the annihilation problem are discussed in terms of covariant perturbation theory. When applied to the proper annihilation, perturbation theory gives results resembling those of a statistical theory in which the pion's statistical parameter is small, but increasing slightly with multiplicity (at fixed energy). Experiments are shown to verify these results. (auth)

20859 CONCERNING THE DETERMINATION OF RADIUM EQUIVALENTS OF SOME GAMMA RADIATORS BY IONIZATION CHAMBERS. R. Hoehle and W. Zimmerman (Institut für Angewandte Radioaktivität, Leipzig). Atomkernenergie, 8: 98-101(Mar. 1963). (In German)

For the method of determining the activity of gamma radiators by way of a comparison of the radiation effect with a radium standard preparation, the radium equivalents of some gamma radiators are reported on for 2 types of ionization chambers. The range of application of these ionization chambers extends from a few μg to several 100 mg of Ra equivalent. By using the energy-depending presentation of radium equivalents, a method is given for determining the radium equivalents of any gamma radiators. This method, however, assumes knowledge of the spectrum of these radiators. (auth)

20860 THE ABSORPTION OF HIGH-ENERGY RADIATION, A MONTE CARLO STUDY. I. RECTANGULAR GEOMETRY. N. R. Steenberg and W. Van Iterson (Univ. of Toronto). Can. J. Phys., 41: 632-50(Apr. 1963).

As part of an investigation of the scattering of high-energy radiation by nuclei, a Monte Carlo study was made of the attenuation of radiation by a rectangular barrier composed of a moderately dense random array of rigid semiopaque spheres. The attenuation is found to be much more rapid than that predicted by the rare-gas formula usually assumed and is well described by an alternative formula that is derived on probabilistic grounds. A corollary is that an effective cross section which is substantially larger than the free cross section must be assumed inside such a medium. (auth)

20861 THE ABSORPTION OF HIGH-ENERGY RADIATION, A MONTE CARLO STUDY. II. SPHERICAL GEOMETRY. N. R. Steenberg (Univ. of Toronto). Can. J. Phys., 41: 651-63(Apr. 1963).

The absorption of radiation in a spherical obstacle composed of rigid spheres was studied. The result is the absorption cross section of such an obstacle as a function of the free cross section and the number A of the individual spheres and of packing density. It is found that the usual rare-gas formula represents the cross section adequately. The analysis is applied to nuclear data for the absorption of 25-Bev/c protons by nuclei. It is found that for a nuclear radius $R = r_0 A^{1/3} + \delta$, where δ is the radius of the nucleon, $r_0 = 1.17$ fermi, $\delta = 1.05$ fermi, and an average nucleon transparency $a^2 = 0.30$ is consistent with the data. (auth)

20862 NUCLEON-NUCLEON POTENTIAL DUE TO K MESONS IN NONLOCAL INTERACTION THEORY. Pham Xuan Yem. Compt. Rend., 256: 1452-4(Feb. 11, 1963). (In French)

In calculating the fourth order S matrix for the elastic scattering of two nucleons in a nonlocal strong interaction scheme, $\Lambda - N$, a nuclear potential is obtained that is the

sum of a central potential, of a tensor potential, and of potentials depending on spin-orbit, quadratic spin-orbit, and spin-spin couplings. The latter presents a hard core. (tr-auth)

20863 VECTOR MESONS IN THE THEORY OF THE RELATIVISTIC ROTATOR FOR ELEMENTARY PARTICLES. Mohammed Mebkhout and Francis Halbwachs. Compt. Rend., 256: 1681-4(Feb. 18, 1963). (In French)

The "local gauge" theory is applied to the internal gauge group of the relativistic rotator theory, and three systems of three vector mesons coupled with elementary particles appear. The Yang and Mills theory is thus extended. An interpretation of bosons as bound fermion-antifermion states is deduced. (tr-auth)

20864 GENERAL STUDY OF HYPERFRAGMENTS PRODUCED IN INTERACTIONS OF K^- MESONS AT 1.5-Bev/c WITH THE NUCLEI OF IONOGRAPHIC EMULSIONS. Germain Baumann, Henri Braun, and Pierre Cueer. Compt. Rend., 256: 1736-9(Feb. 18, 1963). (In French)

The general properties of hyperfragments obtained in the interaction of mesons (K^-) at 1.5-Bev/c are analyzed. A slight decrease of the emission frequency with respect to hyperfragments produced in mesons (K^-) of 800 Mev/c was detected, but the mean energy of the hyperfragments is higher than in the last case. (tr-auth)

20865 MEASUREMENT OF THE ELECTRIC AND MAGNETIC FORM FACTORS OF THE PROTON FOR A SQUARE OF THE 4-MOMENTUM TRANSFER OF 0.60 $FERMI^{-2}$. Boris Dudelzak and Pierre Lehmann (Université, Paris). Compt. Rend., 256: 1962-5(Feb. 25, 1963). (In French)

The cross section of electron-proton scattering was measured at two angles $\Theta = 60$ and 150° for the same 4-momentum transfer $q^2 = 0.60$ $Fermi^{-2}$. The proton form factors $F_{magnetic} = 0.904 \pm (1.7\%)$ and $F_{charge} = 0.919 \pm (1.2\%)$ were deduced. The hypothesis $F_{ch} = F_m$ was compared with these results and with previous results obtained for $q^2 = 1.00$, 2.00, and 2.98 $Fermi^{-2}$. It was found that for $q^2 \leq 3$ $Fermi^{-2}$, $F_m/F_{ch} = 1 + (0.0038 \pm 0.0041)\,q^2$. (tr-auth)

20866 ONE-PION EXCHANGE MODEL IN HIGH ENERGY NUCLEON-NUCLEON COLLISIONS. P. Smrž and V. Šimák (Inst. of Physics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 12: 885-93(1962). (In English)

The one pion exchange model is applied to the investigation of inelastic proton-nucleon interactions with a primary kinetic energy of 8.3 Bev. The experimental comparison is carried out using a modified momentum-energy four-vector of the virtual pion, $\overline{\Delta}$, which is determined from the energy and angle of emission of the recoil nucleon. It is shown that the OPE model — if the pion-nucleon resonance ($T = {}^3/_2$) effects are included — may describe the basic mechanism of peripheral interactions for $\overline{\Delta^2} < 0.2 \approx (3\mu)^2$. (auth)

20867 PARAMETRIC CORRELATION IN THE EFFECTIVE RANGE THEORY USING MANDEL'SHTAM'S DISPERSION RELATIONS. V. I. Lend'el, Yu. M. Lomsadze, and B. M. Ernst. Dokl. i Soobshch, Uzhgorodsk. Gos. Univ., Ser. Fiz. Mat. Nauk, No. 4, 19-21(1961).

A new form of experimental data approximation, proceeding from the analytic characteristics of the energy variable of the singlet amplitude of fixed angle p-p scattering, was used to determine more accurately the coupling constant f^2, which turned out to be somewhat less than the universally adopted value $f^2 = 0.08$. Determinations of the parameters of the effective range theory were also made and found to be very near those specific to the Yukawa potential. (P.C.H.)

20868 AN EXAMPLE OF BUNDLE OF Mu-MESONS IN EXTENSIVE AIR SHOWER. Saburo Miyake, Kensaku Hinotani, Tasunosuke Kaneko, and Nobuo Ito (Osaka City Univ.). J. Phys. Soc. Japan, 18: 464-5(Mar. 1963). (In English)

A cloud chamber picture exhibits a bundle of μ mesons in extensive air shower (EAS) whose size is 5×10^5 and axial position is about 5 μ from the center of the cloud chamber. Assuming that their momentum is the same as the average momentum of μ mesons near the core and that the production height of this event is a few kilometers from the observation level, the total energy, transverse momentum, and mass of the primary unstable parent are estimated. (C.E.S.)

20869 ON THE USE OF THE BORN APPROXIMATION FOR SMALL PHASE-SHIFTS AT LOW ENERGIES. P. Swan (Univ. of Melbourne). Nucl. Phys., 42: 134-8(Apr. 1963). (In English)

The validity of the Born approximation for small phase shifts at low energies is discussed. It is shown to be a poor approximation for two-body collisions and most many-body collisions, but works well in the latter case if the potential term in the wave equation is much smaller than the exchange kernel terms. (auth)

20870 NUCLEON-NUCLEON SCATTERING WITH FULL RECOIL. E. Gotsman and S. Hochberg (Imperial Coll. of Science and Tech., London). Nucl. Phys., 42: 139-48(Apr. 1963). (In English)

Using the Tamm-Dancoff-Dyson formalism, the potentials corresponding to one pion exchange (OPEP) and two pion exchange (TPEP) are calculated with full recoil. The method of helicities is used to reduce the integral equation to its scalar form. The equation is solved in momentum space, and the corresponding phase shifts for the OPEP computed for uncoupled states. Results indicate that the major contribution to the phase shifts for higher angular momentum states ($L \geq 2$) comes from the OPEP. (auth)

20871 EFFECT OF ($\overline{K}$-K) RESONANCE IN COLLISIONS OF K-MESONS AND PIONS WITH NUCLEONS. V. Gupta and Y. Singh (Tata Inst. of Fundamental Research, Bombay). Nucl. Phys., 42: 149-55(Apr. 1963). (In English)

Gross tests, in the form of equalities and inequalities, for the charge independence are given for the reactions $\overline{K} + N \rightarrow Y + \overline{K} + K$ and $\pi + N \rightarrow N + \overline{K} + K$. The effect of the K-K resonance in these reactions is considered. (auth)

20872 THE EFFECT OF AN S-WAVE PION-PION INTERACTION ON PION-NUCLEON SCATTERING. J. E. Bowcock and J. C. Stoddart (Manchester Univ., Eng.). Nucl. Phys., 42: 156-65(Apr. 1963). (In English)

Using the helicity amplitude expansion of Frazer and Fulco for the π-π scattering amplitudes, and a conformal mapping method, the effect of an s-wave π-π interaction on the isobaric (+) combination of meson(π)-nucleon phase shifts is investigated. It is concluded that a range of the π-π s-wave scattering length, $0.5 \leq \alpha_0 \leq 1.4$, corresponding to a maximum in the π-π s-wave phase shift, $\delta^0_{++}(t)$ of about ${}^1/_8\pi$ between $t = 6$ and 25, is allowed by the analysis, and that this range of α_0 is in agreement with other experimental information. (auth)

20873 A GENERALIZATION OF FIELD QUANTIZATION AND STATISTICS. II. INTERACTING FIELDS. S. Kamefuchi and J. Strathdee (Imperial Coll. of Science

and Tech., London). Nucl. Phys., 42: 166-76(Apr. 1963). (In English)

The generalized method of quantization is extended via suitable modifications of the usual commutation relations between different fields so as to allow the incorporation of interactions. A consequence of the structure of these modified commutation relations is the existence of a super-selection rule concerning the numbers of particles of each statistical type. By means of this super-selection rule and of some quantitative consequences of the theory, one is able to establish that all of the known elementary particles obey either Fermi-Dirac or Bose-Einstein statistics. (auth)

20874 THE MUTUAL COHERENCE OF INCOHERENT RADIATION. M. Beran (Univ. of Pennsylvania, Philadelphia) and G. Parrent, Jr. Nuovo Cimento (10), 27: 1049-65(Mar. 1, 1963). (In English)

It is shown that the Dirac δ function form, often assumed for the mutual power spectrum $\hat{\Gamma}(S_1,S_2,\nu)$, to represent incoherent radiation, may be replaced by a finite form. It is pointed out that there are many other similar finite forms that serve to represent sources termed incoherent, the proper form depending upon the particular source properties. (auth)

20875 INELASTIC TWO-PRONG INTERACTIONS OF 18 Gev/c PIONS IN PROPANE BUBBLE CHAMBER. M. I. Ferrero, C. M. Garelli, A. Marzari Chiesa, and M. Vigone (Università, Turin and Istituto Nazionale di Fisica Nucleare, Turin). Nuovo Cimento (10), 27: 1066-77(Mar. 1, 1963). (In English)

The study is reported of 18 Bev/c π^- meson interactions in which only one or two pions are produced. The results give support to the assumption that for these events one-pion exchange is the dominant process. A tentative interpretation of the pion-pion vertex structure is also given. (auth)

20876 BINDING ENERGIES OF HYPERNUCLEI WITH MASS NUMBER A > 5. R. G. Ammar (Northwestern Univ., Evanston, Ill.), L. Choy, W. Dunn, et al. Nuovo Cimento (10), 27: 1078-86(Mar. 1, 1963). (In English)

Results are presented on the binding energies of hypernuclei of mass number A > 5. The data from 56 π^- decays of such hypernuclei are analyzed. Problems in the identification of the heavier hypernuclei are discussed. The possible existence of an isomeric state of $_{\Lambda}He^7$ is considered. (auth)

20877 HOLOMORPHY DOMAINS AND ASYMPTOTIC FORMS OF SCATTERING AMPLITUDES AND PARTIAL WAVE AMPLITUDES. J. L. Challifour and R. J. Eden (Cambridge Univ., Eng.). Nuovo Cimento (10), 27: 1104-15(Mar. 1, 1963). (In English)

The use and limitations of the integral transforms that relate scattering amplitudes A(s,z) (z = cos θ) to partial wave amplitudes a(l,s) are studied. From a modification of the Regge representation, the holomorphy domains of A(s,z) in the z plane when a(l,s) is assumed to be holomorphic and of exponential type in a wedge in the l plane are studied. The inverse relation giving a(l,s) in terms of A(s,z) is also studied under certain assumed analyticity properties of A(s,z) in the variable z, with particular reference to the holomorphy and asymptotic form in l of a(l,s). We also study the analytic continuation in s of a(l,s) using its integral representation in terms of A(s,z), which is necessary in a relativistic theory. It is found that there is a phase difference between the partial wave amplitude defined for $s > 4M^2$ and continued to $s < 4M^2$, and the amplitude defined for $s < 4M^2$. This difference is related to the kinematic branch cut off a(l,s) along $s < 4M^2$ when l is complex. (auth)

20878 QUANTUM-MECHANICAL CORRELATION THEORY OF ELECTROMAGNETIC FIELDS. J. Sarfatt (Technical Operations Research, Burlington, Mass.). Nuovo Cimento (10), 27: 1119-29(Mar. 1, 1963). (In English)

A quantum-mechanical calculation of the space and time correlation functions of the electric field components in blackbody radiation is presented. The results obtained agree with those of a technique based on an analogy with the theory of isotropic turbulence of an incompressible fluid. The feasibility of actually measuring the correlation functions is discussed. (auth)

20879 CONTRIBUTION OF THE PION-PION INTERACTION TO LOW ENERGY PION-NUCLEON SCATTERING. M. Carrassi (Università, Genoa and Instituto Nazionale di Fisica Nucleare, Genoa) and G. Passatore. Nuovo Cimento (10), 27: 1156-67(Mar. 1, 1963). (In English)

The contribution of the pion-pion interaction to low-energy S- and P- phase shifts for pion-nucleon scattering is calculated in a relativistic way. The relativistic effects are shown to be very important, and for the parameter C_1 a value of -0.95 ± 0.2 is found. The relation of these results to the nonrelativistic case is also discussed. (auth)

20880 A NOTE ON THE THEORY OF FINAL STATE INTERACTIONS. M. Nauenberg (Brookhaven National Lab., Upton, N. Y.). Nuovo Cimento (10), 27: 1168-74(Mar. 1, 1963). (In English)

Using requirements of analyticity and the unitarity of the S-matrix, the dependence of a transition amplitude on the invariant mass of two particles in the final state is obtained, when these are strongly coupled to other two-particle channels. As an example, the production of a $\Sigma\pi$ state near the Y_0^* resonance is considered, assuming it is coupled to a $\overline{K}N$ state in an $s_{\frac{1}{2}}$ state. (auth)

20881 ON THE UNIFICATION OF MATTER FIELDS. A. Das (Jadavpur Univ., Calcutta). Nuovo Cimento (10), 27: 1175-8(Mar. 1, 1963). (In English)

Heisenberg-type nonlinear unifying equations in difference form are derived. It is noticed that electromagnetic self-interaction can give rise to other forms of self-interaction. (auth)

20882 AMPLITUDE PARITY AND RADIATIVE EFFECTS IN PION SYSTEMS. G. Barton (Clarendon Lab., Oxford). Nuovo Cimento (10), 27: 1179-84(Mar. 1, 1963). (In English)

It is assumed that the electromagnetic couplings of strongly interacting systems can in principle be accounted for by a renormalizable theory. From this it is proven, by an invariance argument, that real or virtual processes in which an odd number of pions are created or destroyed must proceed through virtual nucleon-antinucleon intermediate states. Examples are $\pi^0 \to 2\gamma$, $\omega \to \gamma$, and $\eta \to 3\pi$. Some implications are discussed. (auth)

20883 RENORMALIZATION GROUP AND COMPLETENESS OF FIELD THEORIES. NUCLEON-PION COUPLINGS. E. R. Caianiello and M. Marinaro (Università, Naples and Istituto Nazionale di Fisica Nucleare, Naples). Nuovo Cimento (10), 27: 1185-1207(Mar. 1, 1963). (In English)

The problem of the mathematical consistency of a field theory defined by a given local Hamiltonian is studied in terms of the propagator (Green's function) formalism. It is necessary for the mathematical consistency of a theory that all the branching equations satisfied by its propagators be covariant under the transformations of its renormaliza-

tion group (which can be explicitly written). This analysis (which differs in method, but not in principle, from the standard renormalization program) permits a systematic and explicit determination of all the terms that need be added to the original incomplete Hamiltonian, for which covariance cannot be secured for the set of branching equations obtained from it alone. Local non-renormalizable theories are mathematically meaningless, because they originate from only fragments of Hamiltonians, which are meaningful only if taken as wholes; the missing terms (even if infinite in number) can be exactly reconstructed with the present method, which leads naturally to an identification of the concepts of mathematical consistency and of physical completeness. All meaningful reactions among coupling constants, such as symmetry requirements, must remain invariant under the renormalization group, which plays a role as important in the search for completeness, as that of the gauge group in electrodynamical problems. For the sake of concreteness, and as a first example, this method is illustrated with reference to the study of the standard meson-nucleon couplings, scalar and pseudoscalar, neutral and charged; the φ^3 and φ^4 (scalar), φ^4 (pseudoscalar) terms are obtained (an erroneous statement about the renormalizability of the neutral scalar coupling is corrected, so that the results agree with the expected ones). (auth)

20884 HEAVY PSEUDOSCALAR MESONS AND THE $P_{3/2}$ RESONANCES. R. H. Capps (Institute for Theoretical Physics, Copenhagen and Università, Rome). Nuovo Cimento (10), 27: 1208-27(Mar. 1, 1963). (In English)

It is assumed that the (3,3) pion-nucleon resonance, the Y_1^*, and the pion-cascade resonance are all caused by the pseudoscalar meson-baryon interactions involving pions, η mesons, and K mesons. Many-channel P-wave dispersion relations are written down and used to show that if the η- and K-pseudoscalar coupling constants are comparable to the $\pi N N$ coupling constant, the heavy meson interactions may play a crucial role in producing the resonances. Two detailed models are considered, the first involving only pion and η interactions, and the second involving π, η, and K interactions related by a particular form of the octet model of unitary symmetry. A comparison is made of the predictions of the two models with respect to the resonance widths and shapes, and the quantum numbers of states where resonances or strong attractions are expected in P-states. The Ξ^* width predicted by the unitary symmetry model is approximately 6 Mev. (auth)

20885 NUCLEON FORM FACTORS AND RESONANCE PARTICLES. S. Gotô (Università, Naples). Nuovo Cimento (10), 27: 1249-61(Mar. 1, 1963). (In English)

Nucleon form factors are discussed on the assumption that there are no lighter particles, which have dominant contributions to the nucleon structures, than ρ and ω. The form factors are determined experimentally by taking into account effects of higher-mass states. The four-pion state is considered as a higher mass state, and for this purpose a model is taken in which the four pions are replaced by pion and ω. Results of calculations have a qualitatively "good" tendency compared with the form factors. It seems that the possibility of the original assumption cannot be excluded by current experiments. (auth)

20886 Σ BREAKUP AND THE $\Sigma\Lambda$ RELATIVE PARITY. K. Hiida (Argonne National Lab., Ill.), J. L. Uretsky, and R. J. Oakes. Nuovo Cimento (10), 27: 1262-5(Mar. 1, 1963). (TID-16261; UAC-6454). (In English)

It is shown that studies of the reactions $\Sigma^+ + p \rightarrow \Lambda + \pi^+ + p$ and $\Sigma^- + p \rightarrow \Lambda + n$ can yield information on the Σ-Λ relative parity and the $\pi\Lambda\Sigma$ coupling constant. (T.F.H.)

20887 ON THE SYMMETRY OF ELEMENTARY PARTICLES. [PART] II. A. O. Barut (Univ. of Colorado, Boulder). Nuovo Cimento (10), 27: 1269-71(Mar. 1, 1963). (In English)

Lattice-theoretical considerations are used to develop a hexagonally symmetric model for the stable particles and the $I < 3/2$ resonances (and their antiparticles). Resonances having $I \geq 3/2$ are not considered. (T.F.H.)

20888 ON THE MATHEMATICAL STRUCTURE OF THE MULTIPERIPHERAL EQUATION. B. W. Lee and A. R. Swift (Univ. of Pennsylvania, Philadelphia). Nuovo Cimento (10), 27: 1272-6(Mar. 1, 1963). (In English)

It is shown that the kernel of the eigenvalue equation of the multiperipheral scattering model is related to the kernel of the eigenvalue equation associated with the Bethe-Salpeter equation for Regge trajectories by a similarity transformation. Thus the eigenvalues that give the Regge trajectories coincide in the multiperipheral model and in the Bethe-Salpeter equation. Approximations to the eigenvalue equation under consideration are discussed. (T.F.H.)

20889 ASYMPTOTIC BEHAVIOR OF THE SCATTERING AMPLITUDE FOR PARTICLES WITH ARBITRARY SPINS. K. Yamamoto (Univ. of Chicago). Nuovo Cimento (10), 27: 1277-80(Mar. 1, 1963). (In English)

The trace, with respect to the spin variables, of the elastic scattering amplitude for particles having arbitrary spin is considered. The boundedness properties of these amplitudes, and of the cross sections associated with them, are determined as functions of the scattering angle. (T.F.H.)

20890 MONOCHROMATIC BREMSSTRAHLUNG FROM THIN CRYSTALS. R. F. Mozley (Stanford Univ., Calif.), and J. DeWire. Nuovo Cimento (10), 27: 1281-5(Mar. 1, 1963). (In English)

It is shown that if the bremsstrahlung from a thin, perfect, single crystal is viewed with a small angle of acceptance (on the order of 1 mc^2/E_0, where E_0 is the incident electron energy and m is its mass), the bremsstrahlung spectrum is composed of a series of near-monoenergetic spikes, which have heights that decrease with photon energy. (T.F.H.)

20891 PRODUCTION OF EXCITED K-MESONS ON COMPLEX NUCLEI. A. F. Grashin, E. V. Kuznetsov, and Ya. Ya. Shalamov (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Letters, 4: 71-2(Mar. 15, 1963). (In English)

To test whether the K^* resonance of mass 885 Mev leads to any appreciable broadening of the mass spectrum of the π bimeson system, the missing mass spectrum determined on Λ hyperons from the reaction $\pi^- + N \rightarrow \Lambda + K + n\pi$ was investigated. The particles were identified and their momenta were determined by the decay product flight angles relative to the decayed-particle trajectory and by ionization and range of decay products. (C.E.S.)

20892 A POSSIBLE METHOD TO OBTAIN EVIDENCE ON THE SPINS AND PARITIES OF EXCITED BARYONS. D. B. Lichtenberg (Stanford Linear Accelerator Center, Stanford, Calif.). Phys. Letters, 4: 73-4(Mar. 15, 1963). (In English)

An extension of the Adair analysis is proposed in which the spin and parity of excited baryons can be determined from a single decay angular distribution without measurement of the polarization of any decay products. If the excited state decays into a spin $3/2$ particle and a spin 0 meson, the decay angular distribution depends on both the spin and parity. (C.E.S.)

20893 CONTRIBUTION OF ρ- AND ω-MESONS TO K–N SCATTERI 3 AT LOW ENERGIES. V. A. Lyul'ka

and A. A. Startzev (Kurchatov Inst. for Atomic Energy, Moscow). Phys. Letters, 4: 74-5(Mar. 15, 1963). (In English)

The contribution of long-range forces to the amplitude of the K–N scattering at low energies is considered by means of the simplest Feynman diagrams corresponding to the exchange of ρ and ω mesons. It is shown that the exchange of ω mesons gives a greater contribution to the long-range forces of K–N scattering than the exchange by ρ mesons. (C.E.S.)

20894 HIGHER SYMMETRIES AND CURRENT CONSERVATION. Y. Ne'eman (Israel Atomic Energy Commission Labs., Rehovoth and Tel-Aviv Univ., Israel). Phys. Letters, 4: 81-3(Mar. 15, 1963). (In English)

A method to produce the necessary conserved currents for weak interactions in full agreement with the strong interaction symmetry of the Gell-Mann–Ne'eman model is presented. A simplified hypothetical theory is illustrated invoking the Σ hyperon triplet as a basic model. (C.E.S.)

20895 ON THE EXPERIMENTAL VERIFICATION OF THE SINGLE REGGE-POMERANCHUK POLE APPROXIMATION FOR HIGH-ENERGY ELASTIC SCATTERING. E. Marquit (Univ. of Warsaw). Phys. Letters, 4: 101-2 (Mar. 15, 1963). (In English)

The increase in the size of the proton-proton interaction region in terms of a single Regge-Pomeranchuk pole for the high-energy asymptotic region is investigated. Values obtained over a wide range of the total cms energy for small intervals of the 4-momentum transfer are compared. The values obtained give no clear indication of the dependence of the proton-proton interaction region on the primary energy. (C.E.S.)

20896 LIMITATIONS ON THE THREE PARTICLE VERTEX PART. B. V. Geshkenbein and B. L. Ioffe (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Letters, 4: 162-3(Apr. 1, 1963). (In English)

Assuming the coupling constant of three fields to be given and that the coupling constant is a known function of the masses of the three particles, a method is derived to find the limits within which the vertex part of the three particles can change at any arbitrary point. The case in which the three particles are bosons with spin 0 is considered. (C.E.S.)

20897 CHARGE-EXCHANGE AND TOTAL CROSS SECTION IN π-p INTERACTIONS AT HIGH ENERGIES. G. Bellini (Istituto di Fisica and Istituto Nazionale di Fisica Nucleare, Milan), E. Fiorini, and A. Orkin-Lecourtois. Phys. Letters, 4: 164-6(Apr. 1, 1963). (In English)

The cross sections for 0-prong interactions of 6.1 and 18.1 Bev/c mesons (π^-) on protons and their correlation with total cross sections at high energies were investigated. The analysis was done on photograms of a heavy liquid bubble chamber containing a mixture of propane and freon exposed to meson (π^-) beams. Results support the hypothesis that elastic charge-exchange cross sections vanish at high energies since charge-exchange represents only one of the inelastic channels that becomes arbitrarily large with increasing energy. (C.E.S.)

20898 γ_5-INVARIANCE AND FERMION MASS. W. Thirring (Universität, Vienna). Phys. Letters, 4: 167(Apr. 1, 1963). (In English)

It is shown that a pole in the proper self-energy part leads to a fermion mass in a γ_5-invariant theory. On general grounds γ_5-invariance implies either mass zero or a degeneracy corresponding to fermion CP-doublets. The necessary and sufficient conditions for a mass to emerge in a γ_5-invariant theory are presented. (C.E.S.)

20899 COMPARISON OF π-p AND p-p ELASTIC SCATTERING ON THE BASIS OF A MODEL WITH THREE REGGE POLES. V. P. Kanavatz, I. I. Levintov, and B. V. Morosov (Inst. of Theoretical and Experimental Physics, Moscow). Phys. Letters, 4: 196-7(Apr. 1, 1963). (In English)

The possibility of interpreting the meson ($\pi^\pm$)-proton and proton-proton elastic scattering data on the basis of a model with three Regge poles is considered. It is shown that the whole complex of meson ($\pi^\pm$)-proton scattering data cannot be in agreement with known proton-proton data in the framework of the three pole model. (C.E.S.)

20900 REMARK ON THE "GHOST" PROBLEM IN THE VACUUM POLE TRAJECTORY. R. G. Newton (Università, Rome). Phys. Letters, 4: 201(Apr. 1, 1963). (In English)

The problem of the residue of the elastic nucleon-nucleon scattering amplitude at the leading vacuum or Pomeranchuk pole (P) when P passes through $\alpha = 0$ is considered. The generalization of a symmetry relation in the nonrelativistic Regge method is used. (C.E.S.)

20901 EXPERIMENTAL EVIDENCE FOR THE CONSTANCY OF THE VELOCITY OF GAMMA RAYS, USING ANNIHILATION IN FLIGHT. D. Sadeh (Israel Atomic Energy Commission, Nahal Soreq Establishment, Rehovoth). Phys. Rev. Letters, 10: 271-3(Apr. 1, 1963).

The annihilation in flight of positrons was used to determine the constancy of gamma ray velocity as a test for the second postulate of special relativity. In the annihilation the center-of-mass system of the positron and electron moves with a velocity close to $\frac{1}{2}$ C, and two gamma rays are emitted. In the case of annihilation at rest, the two gamma rays are emitted at an angle of 180° and their velocity is C. In the case of annihilation in flight, the angle is smaller than 180° and depends on the energy of the positron. It is clear from the experimental data that the velocity of the gamma rays is constant (±10%) and does not add to the velocity of the source. (C.E.S.)

20902 NONSHRINKING DIFFRACTION SCATTERING. Y. Nambu (Univ. of Chicago) and M. Sugawara. Phys. Rev. Letters, 10: 304-7(Apr. 1, 1963).

Arguments suggesting that the forward peak of high-energy elastic scattering does not shrink are presented. It is shown that both p-p and π-p scattering are not only consistent with, but rather suggestive of no shrinkage. Arguments supporting no shrinkage in terms of a complex, energy-dependent effective potential are presented. A more specific model of high-energy elastic scattering is constructed that predicts no shrinkage and produces a finite (non zero) total cross section in the limit of infinite energy. (C.E.S.)

20903 EXAMPLE OF $\Sigma^+ \rightarrow p + \gamma$ IN A HYDROGEN BUBBLE CHAMBER. R. A. Burnstein (Univ. of Maryland, College Park), T. B. Day, F. Martin, M. Sakitt, R. G. Glasser, N. Seeman, and A. J. Herz. Phys. Rev. Letters, 10: 307-8(Apr. 1, 1963).

Evidence of a $\Sigma^+ \rightarrow p + \gamma$ decay is presented in which the Σ^+ was produced by a K^- at rest in a hydrogen bubble chamber. (C.E.S.)

20904 EMPIRICAL RELATIONS INVOLVING THE HYPERONS AND BARYON ISOBARS. R. M. Sternheimer (Brookhaven National Lab., Upton, N. Y.). Phys. Rev. Letters, 10: 309-10(Apr. 1, 1963).

Three mass relations are pointed out that may be useful

in extending a model of π-N interactions to strange particles and hyperon isobars. (C.E.S.)

20905 PREDICTION OF AN INTERACTION SYMMETRY FROM DISPERSION RELATIONS. Richard H. Capps (Universitá, Rome). Phys. Rev. Letters, 10: 312-14(Apr. 1, 1963).

An approximate set of dispersion relations is presented that leads to the prediction of interaction symmetry. The pseudo-scalar (PS) mesons, π, K, and η are considered, and their mass differences neglected. The vector mesons ρ, ω, and K*, with mass differences neglected, are considered as resonances or bound states of the various pairs of PS mesons, and the coupling constants $\gamma_{\rho\pi\pi}$, $\gamma_{\rho kk}$, $\gamma_{\omega kk}$, $\gamma_{k^*\pi k}$, and $\gamma_{k^*\eta k}$ are computed. The ratios of these computed constants are found to be in exact agreement with predictions of the octet model of unitary symmetry. (C.E.S.)

20906 LOW ENERGY CHARGED MESON PHOTOPRODUCTION. J. K. Walker, J. G. Rutherglen, D. B. Miller, and J. M. Paterson (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 78-82(Jan. 1, 1963).

Photoproduction of charged π^+ mesons from hydrogen at 50° in the laboratory and at gamma-ray energies between 160 and 200 Mev is described. The results of the present experiment, together with recent results at higher energies reported by the Bonn group, are in good agreement with the fixed-momentum dispersion relation predictions of Chew, Goldberger, Low, and Nambu. Following the suggestion of Baldin, the comparison of the data and theory was performed in a manner such that the momentum transfer to the nucleon was fixed and equal to that occurring at threshold, thereby eliminating certain unknowns in the theory. (auth)

20907 PHOTOPRODUCTION OF NEGATIVE PIONS IN DEUTERIUM. H. C. Evans (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 83-9(Jan. 1, 1963).

The energy spectrum at 30° and the angular distribution of protons produced in the reaction $\gamma + d \rightarrow p + p + \pi^-$ were measured. A thin liquid deuterium target was irradiated by the 307 Mev bremsstrahlung beam of the Glasgow electron synchrotron. A proton was detected in coincidence with the negative pion using scintillation counter telescopes. The pions were detected at 90° ± 4° in an energy range from 46 to 60 Mev. The results are in agreement with the predictions of the spectator model and the impulse approximation. (auth)

20908 LONG RANGE ELECTRON DENSITY OSCILLATIONS AT NON-ZERO TEMPERATURES. C. P. Flynn and R. L. Odle (Univ. of Illinois, Urbana). Proc. Phys. Soc. (London), 81: 412-15(Mar. 1, 1963).

The form of the electron density surrounding a spherically symmetric defect in a Fermi gas at non-zero temperature is calculated. At large distances and moderate temperatures the density decay contains an amplitude correction factor and reduces at zero temperature to the well-known inverse cube dependence of amplitude on distance. (auth)

20909 SECOND QUANTIZATION OF THE GENERAL MANY FERMION OPERATOR. E. R. Pike (Royal Radar Establishment, Great Malvern, Worcs, Eng.). Proc. Phys. Soc. (London), 81: 427-30(Mar. 1, 1963).

The second-quantized equivalent of the general particle-conserving operator in the configuration space of Slater determinants is found by a direct calculation. The usual one and two-particle operators are found as special cases and their equivalence with the corresponding configuration-space operators is thus shown without a lengthy comparison of either signs or matrix elements. (auth)

20910 PRODUCTION OF Y* IN K^- CAPTURE IN A TWO-NUCLEON SYSTEM. S. T. H. Abidi and B. K. Mohanty (Indian Inst. of Tech., Kharagpur). Proc. Phys. Soc. (London), 81: 470-2(Mar. 1, 1963).

An isobaric spin analysis of the capture of K^- mesons in a two-nucleon system was carried out. The production ratios of pion–hyperon resonances Y*'s produced in these reactions are evaluated, and some relationships between the cross sections of these absorption processes are found. The analysis is then extended to the capture of K^- mesons in light nuclei, helium, and deuterium. (auth)

20911 ELECTRON CAPTURE BY FAST PROTONS AND α-PARTICLES IN HYDROGEN. M. B. McElroy (Queen's Univ., Belfast). Proc. Roy. Soc. (London), Ser. A, 272: 542-56(Apr. 9, 1963).

Cross-sections are calculated for the accidental resonance reaction, $He^{2+} + H(1s) \rightarrow He^+(2s \text{ or } 2p) + H^+$, and the non-resonance reaction, $H^+ + H(1s) \rightarrow H(2s \text{ or } 2p) + H^+$, by means of the method due to Bates in which account is taken of the non-orthogonality of the wave functions describing the initial and final states. Proper allowance is made for the effects of distortion and of momentum transfer. The calculations are carried out for incident ion energies in the range 25 to 800 kev. In the accidental resonance case, the cross-section is small at low velocities of relative motion, and tends rapidly towards zero as the velocity is decreased. In all processes investigated the effect of distortion is considerable. Using the results of McCarroll & McElroy and of McCarroll for capture into the ground states of He^+ and H, the cross-sections for capture into all states are estimated. Comparisons are made with the experimental data of Fite, Smith & Stebbings for the incident alpha particle case and with that of Fite, Stebbings, Hummer & Brackman for the incident proton case. The highest energy for which cross-sections are measured in either case is 40 kev. (auth)

20912 ISOBARIC MODEL FOR K^--p COLLISIONS AT K^- MOMENTUM 1150 Mev/c. Yogendra Mohan Gupta, Vinod Prakash Gautam, and Bipin Kumar Agarwal (Allahabad Univ., India). Progr. Theoret. Phys. (Kyoto), 28: 959-66(Dec. 1962). (In English)

The isobar nucleon model of Lindenbaum and Sternheimer is extended to K^--p collisions. The reaction is assumed to be $K^- + p \rightarrow Y^* + \pi$ followed by the Y* (isobar) decaying into a Λ and a meson(π). Y* has isotopic spin 1. Calculations for the various meson(π) energy spectra and for momentum spectrum were carried out for incident K^- momentum 1150 Mev/c. A reasonable agreement is found between isobar model calculations and experimental data of Alston et al. The validity of assumptions regarding isotropic and isolated decay of Y* is discussed at this momentum. (auth)

20913 ONE BOSON EXCHANGE MODEL IN PROTON-PROTON SCATTERING. AN APPROACH TO THE STRONG INTERACTION. Shoji Sawada, Tamotsu Ueda, Wataro Watari, and Minoru Yonezawa (Hiroshima Univ. and Osaka City Univ.). Progr. Theoret. Phys. (Kyoto), 28: 991-1025 (Dec. 1962). (In English)

A phenomenological model for strong reactions is proposed. In the model it is assumed that the resonance states can be treated as elementary particles as the meson(π) and nucleon and the physical processes can be described by the sum of the lowest order matrix elements. As an application of the model the proton-proton scattering below ~300 Mev is studied. It is shown that the present model can successfully explain the experimental phase shifts if the meson(π), scalar boson, and vector boson dominantly contribute to the nuclear force at this energy region. (auth)

20914 THE HYPOTHESIS OF REGGE POLES AND HIGH ENERGY NUCLEON-NUCLEON SCATTERING. Yasuo Hara (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 28: 1048-58(Dec. 1962). (In English)

High energy NN and $N\bar{N}$ scattering amplitudes and unpolarized and polarized elastic cross sections are expressed in terms of the pole-residues and trajectories of the exchanged Regge poles. By comparing pole-residues at t = 0 with coupling constants of mesons (ρ) and (ω) with nucleon, signs of pole-residues at t = 0 are found to be the same as those at $t = \mu_\rho^2$ or μ_ω^2, and t-dependence of pole-residues is found to be small for $t \geq 0$. An experiment to test the Regge pole hypothesis is proposed. (auth)

20915 STATISTICAL MODEL FOR STRANGE PARTICLE AND ISOBAR PRODUCTION IN PROTON-ANTIPROTON ANNIHILATION. J. S. Kovacs (Michigan State Univ., East Lansing and Brandeis Univ., Waltham, Mass.). Progr. Theoret. Phys. (Kyoto), 28: 1065-79(Dec. 1962). (In English)

The statistical model is applied to the process $P + \bar{P} \rightarrow K + \bar{K} + n\pi$ with the resonances, K^*, ω, and ρ included as intermediate states. The energy range 0.50 to 2.00 Bev ($\bar{P}$ kinetic energy in the laboratory) is considered and results are presented for various combinations of assumptions for the volume parameters, Ω_i. In particular, it is seen that the case when $\Omega_\pi = \Omega_\rho = \Omega_\omega = 4\pi/3(\hbar/m_\pi c)^3$ and $\Omega_{K^*} = \Omega_K$ is not inconsistent with the presently available experimental data for this process. Included in the results are the average meson (π) multiplicity, frequency of isobar production, and charged prong distributions, all as a function of energy. (auth)

20916 BARYON NUMBER CONSERVATION AND THE JOST-LEHMANN-DYSON REPRESENTATION. Gaku Konisi and Kunio Yamamoto (Kwansei Gakuin Univ., Nishinomiya and Osaka Univ.). Progr. Theoret. Phys. (Kyoto), 28: 1080-99(Dec. 1962). (In English)

It is shown that the baryon number conservation has a close relation to the asymptotic behavior of some matrix elements for a large space-like separation of their arguments. This circumstance arises from the fact that, when the baryon number is conserved, the support of the weight function in the Jost-Lehmann-Dyson representation for the commutator is somewhat narrower than in the most general case. The explicit proof is given by means of the perturbation theory. When the support in the Jost-Lehmann-Dyson representation is narrowed in this way, one can prove the dispersion relations for the nucleon vertex function. It is difficult to give the proof in every order of the perturbation theory, because in general diagrams there may appear singularities that should be separated, and it was not known how those singularities can be separated. It can be shown however, in a simple example, that the existence of those singularities only complicates the problem without worsening the situation. Thus there is a good reason to believe that the results obtained here are true, though not proved in every order. (auth)

20917 REGGE POLES IN MULTIPLE MESON PRODUCTION. Hironari Miyazawa and Mahiko Suzuki (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 28: 1102-4(Dec. 1962). (In English)

Consequences of Pomeranchuon exchange in multiple meson production are discussed. The Pomeranchuon exchange comes about as a result of the Reggeization of the exchange boson in high energy multiple meson production processes. In spite of poor statistics, there is indication of the dominance of Pomeranchuon exchange over mesons (π) or (ρ) exchange. (C.E.S.)

20918 COUPLED PARTIAL-WAVE-DISPERSION-RELATION FOR NUCLEON-NUCLEON SCATTERING AND ρ- AND ω-MESON CONTRIBUTIONS. Susumu Furuichi (Rikkyo Univ., Tokyo). Progr. Theoret. Phys. (Kyoto). 29: 235-54(Feb. 1963). (In English)

A coupled integral equation derived from the partial-wave-dispersion-relation for the low energy nucleon-nucleon scattering is solved explicitly in certain conditions. This solution is utilized to clarify the range of reliability of the one-meson(π)-exchange approximation with a scattering-length-correction in the averaged P-wave phase shift, and it is shown that this approximation is a reasonable one in the region where the impact parameter b_1 is larger than ~1.5 meson(π) Compton wavelengths (region I). The meson (ρ) and (ω) exchange contributions are calculated in the zero width approximation, and it is shown that these contributions may not be important except in the $^3P_0$ state, if the effective coupling strengths derived from the electromagnetic form factor of nucleon are used. (auth)

20919 PION PRODUCTION CROSS SECTIONS BY NEUTRINOS AND ANTINEUTRINOS. Mineo Fukawa (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 268-74(Feb. 1963). (In English)

Pion production cross sections by neutrinos and antineutrinos are calculated in the lowest order perturbation theory for neutrino energies of 0.5, 1, 3, 5, and 10 Bev in the laboratory system. It is shown that the inelastic cross section $\nu + p \rightarrow p + e^- + \pi^+$ is much smaller than the elastic cross section at 1 Bev, while the former is about 10 times larger than the latter at 10 Bev. It is also found that the contribution of the Gell-Mann current is appreciable. The interference term between the nucleon current and the Gell-Mann current turns out to be large enough to compete with the direct terms. The antineutrino cross sections are smaller than those of neutrino approximately by a factor of two and the main difference between them comes from the interference term. (auth)

20920 SUBTRACTION OF DISPERSION RELATION IN MULTI-CHANNEL SCATTERING. Tesuro Kitazoe (Osaka Univ.) and Takesi Ogimoto. Progr. Theoret. Phys. (Kyoto), 29: 275-8(Feb. 1963). (In English)

A minimum number of subtractions is determined for the dispersion relation of the inverse scattering amplitude in the multi-channel case, by using the symmetric property of the scattering amplitude and the multi-channel character. (auth)

20921 A THEORY OF ELEMENTARY PARTICLES WITH INTERNAL DEGREES OF FREEDOM. Haruo Shimazu and Kan-ichi Yokoyama (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 29: 279-95(Feb. 1963). (In English)

A field that has internal degrees of freedom is introduced in a nonlocal form, from which elementary particles may be described in a unified way. The interaction of this field is investigated in view of the requirement of convergence. Causality and relativistic invariance do not hold strictly due to the nonlocal character of this field, but a weaker condition holds in such a way that the acausal and non-invariant effects are restricted to a small region of space-time or very high energy phenomena. (auth)

20922 p-p SCATTERING AT 660 Mev. [PART] II. Norio Hoshizaki (Kyoto Univ.). Progr. Theoret. Phys. (Kyoto), 29: 321-2(Feb. 1963). (In English)

It is shown that the values of the rotation parameter R and the spin correlation coefficient C_{nn} predicted in a previous solution are consistent with recent data. The R values predicted by the phase shifts are plotted against

center-of-mass scattering angle Θ, where the relativistic formalism is employed in the calculation. A plot of C_{an} vs. Θ is given for comparison with the new data. (C.E.S.)

20923 N/D METHOD AND INVERSE-AMPLITUDE METHOD. Takeshi Kanki (Osaka Univ., Toyonaka, Japan). Progr. Theoret. Phys. (Kyoto), 29: 322-4(Feb. 1963). (In English)

It is shown that the conventional N/D method gives only such a special solution of the Chew-Mandelstam scattering equation as satisfies the Levinson theorem, while the inverse-amplitude method gives a general solution. (C.E.S.)

20924 THEORY OF THE INTERMEDIARY MESONS. Seitaro Nakamura (Tokyo Univ. and Nihon Univ., Tokyo) and Shigeo Sato. Progr. Theoret. Phys. (Kyoto), 29: 325-8(Feb. 1963). (In English)

The symmetry property and parity of the intermediary mesons are determined by comparing the experiments on the various processes among four fermions. (C.E.S.)

20925 ON THE STRUCTURE OF WEAK INTERACTIONS. Jan Nilsson. Trans. Chalmers Univ. Technol., Gothenburg, No. 258, 1-66(1962). (In English)

Possible ways to study the structure of weak interactions are discussed. It was found that those processes that are most sensitive to the structure may not even exist in nature. The radiative decay of the μ meson is strictly forbidden if there are two kinds of neutrino, but it is a very critical test on any model for weak interactions provided only one kind of neutrino exists. A clarification of this point would remove one of the most intriguing obstacles for further progress towards an understanding of the weak interactions. The observations within the local theory revealed a probable structure for the interactions at distances smaller than about 4×10^{-16} cm. A single, sharp cut-off was applied. Such a crude method can only give a characteristic length for the interaction but tells nothing about finer details. It is obviously too narrow a frame for an understanding of the real nature of the structure. The more general phenomenological approach is too wide a frame in this sense. Although observations can be understood within such a scheme, it is in general not suited for discussions of specific details of observations, but rather serves as a test of some general assumptions in the theory. Nevertheless, in some cases it can provide guiding principles in the search for an underlying structure of the interaction. The hypothesis that weak interactions are mediated by vector bosons is a particularly simple model of a nonlocal four-fermion interaction. Predictions of such a theory can be deduced and tested experimentally. At present some arbitrariness in the theory makes predictions somewhat ambiguous. As the experiments are improved and more processes are being considered, this ambiguity will probably be removed, and it remains to be seen if the intermediate vector boson hypothesis will then be consistent with all aspects of the weak interactions. (auth)

20926 THEORY OF NON-STATIONARY DIFFUSION OF RADIATION. I. N. Minin. Vestn. Leningr. Univ., No. 19, Ser. Mat. Mekh. i Astron. No. 4, 124-32(1962). (In Russian)

Problems of non-stationary diffusion of radiation in one-dimensional semi-infinite and infinite media are considered. Exact solutions of the problems are given by the method based on the Laplace transformation and statistical treatment. The possible applications to the theory of diffusion of particles are discussed. (auth)

20927 THE DENSITY OF DEUTERONS IN A SELF-TARGET IN GOLD. D. Kamke and H. Krueger (Universität, Marburg, Ger.). Z. Naturforsch., 18a: 52-60 (Jan. 1963). (In German)

The distribution of deuterons in a self-target in gold was measured by first saturating the target with a high current of deuterons and then testing the distribution of deuterons by making use of small ion currents of various energies and recording the neutron yield. It is shown that the distribution in deuteron-density is linear for the saturated target. (auth)

20928 ON THE SUPERFLUIDITY OF A BOSE SYSTEM. Wolfgang Weller (Universität, Leipzig). Z. Naturforsch., 18a: 79-85(Jan. 1963). (In German)

A Bose system with a simple repulsive exchange effect potential was examined with the help of thermodynamic Green functions. The condensate was separated by the method of Bogoljubov. Thereby the cases were treated for which the particles of the condensate are in uniform or vortical motion. By means of the whirling motion the circulation was proved to be quantized. (tr-auth)

20929 A NEW FORM OF THE QUANTIZATION OF THE DIRAC EQUATION. Gerhard Simon (Universität, Giessen, Ger.). Z. Naturforsch., 18a: 88-9(Jan. 1963). (In German)

A method for quantizing the Dirac equation, $(\gamma_\mu \delta_\mu + \kappa) \psi = 0$, where γ_μ is the 4 Dirac matrices, δ_μ the four gradients, κ the reciprocal Compton wavelength, and ψ the wave function, is described. The permutation rules have an advantage that the Hamilton operator possesses a non-negative characteristic value without which a transformation would be necessary for the appearance of an infinite constant. (M.C.G.)

20930 HIGHER ORDER MOMENTUM APPROXIMATIONS IN CLASSICAL COLLISION THEORY. Chr. Lehmann and G. Leibfried (Oak Ridge National Lab., Tenn.). Z. Physik, 172: 465-87(1963). (In English)

In the classical theory of collisions between two particles interacting by a central potential, approximate methods are used. Higher-order approximations are treated by expanding the results of classical scattering theory in powers of the potential. In view of the application in slowing-down theory, the discussion was confined to repulsive potentials. Topics covered include: expansion of scattering angle in powers of the potential, the momentum approximation, higher-order approximations, second-order terms, third order terms, remarks on small-angle scattering by cut-off potentials, the exponential and the exponentially screened Coulomb potential, and quantum mechanical limit of classical scattering. (M.C.G.)

20931 ON THE THEORY OF SYSTEMS OF THREE PARTICLES WITH COULOMB RECIPROCAL EFFECTS. U. Schroeder (Universität, Freiburg i. B.). Z. Physik, 173: 221-231(1963). (In German)

The wave functions of muon molecules as well as of the corresponding electron molecules and of the system $e^+ e^- e^+$ were approximated by simple analytical functions, the best choice of parameter values being obtained by straightforward variational procedure. The results are discussed in detail and binding energies tabulated. (auth)

20932 NEW DATA ON π^0 MESON PRODUCTION IN NUCLEAR COULOMB FIELD. V. V. Barmin, Yu. S. Krestnikov, E. V. Kuznetsov, A. G. Meshkovskii, Yu. P. Nikitin, and V. A. Shebanov (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 748-9(Feb. 1963). (In Russian)

Coherent particle-nucleus interactions of the type $\pi^- + {}_Z N^A \rightarrow \pi^- + \pi^0 + {}_Z N^A$ (possibly due to π-meson interactions with the Coulomb field of ${}_Z N^A$) were previously studied using xenon nuclei and 2.8 Bev/c π^- mesons. One identifi-

cation method for $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ reactions was developed using a xenon bubble chamber, and 25 events were selected from 10,000 stereo pictures. The previous work was expanded by independent studies of 15,000 additional pictures, bringing the total number of pictures to 24,474 with 23,400 pictures of inelastic interactions and 53 selected events. The distribution of events according to π^- emission angle was tabulated. The angular function $d\delta/d\Omega$ showed that at π^- emission angle $\geq 15°$ the yield of the reaction is very small. At emission angles between 3 and 30° the participation of the reaction in the total number of inelastic interactions is $n/N_1 = 2.21 \pm 0.75 \times 10^{-3}$. Considering $\delta_{inelast} = 1200$ mb, the cross section of the $\pi^- + Xe \rightarrow \pi^- + \pi^0 + Xe$ reaction at 3 to 30° is $\delta_c = 2.65 \pm 0.90$ mb. The derived data are used in an evaluation of the $\gamma + \pi^- \rightarrow \pi^- + \pi^0$ reaction. (R.V.J.)

20933 ON THE INTERPRETATION OF HIGH-ENERGY NEUTRINO EXPERIMENT. L. I. Lapidus (Joint Inst. of Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 755-8(Feb. 1963). (In Russian)

An interpretation of a Brookhaven experiment with high energy neutrinos was expanded, and it is shown that within the limits of the single neutrino hypothesis it is possible to assume a higher number of muons to the number of electrons. In experiments with 1-Bev neutrinos under Brookhaven conditions, within the frame of the one-neutrino hypothesis, the number of muons exceeded the number of electrons by a factor of 5. This was derived by increasing the pseudoscalar interaction factor and by assuming an equal dependence of all form factors. It is suggested that further experiments are imperative for deciding the muon-electron ratio problem. (R.V.J.)

20934 PRODUCTION OF γ QUANTA IN π^- MESON INTERACTIONS WITH NUCLEONS AT 7 Bev. V. B. Lyubimov, Tsun Mu, M. I. Podgoretskii, S. I. Portnova, V. N. Strel'tsov, and Z. Trka (Joint Inst. for Nuclear Research, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 760-3(Feb. 1963). (In Russian)

An analysis was made of 395 inelastic π^--N interactions that contained 454 e^+e^- pairs. The recording efficiency for π-N interactions and e^+e^- pairs was 98%. A diagram of γ energy distribution in the laboratory system was constructed, and corrections were made for γ quanta from e^+e^- pairs as functions of energy and geometry. The diagram shows that in addition to a maximum for $\pi^0 \rightarrow 2\gamma$ decay there is also a maximum at $E_\gamma = 250$ to 300 Mev. An assumption that the second maximum is related to η decay into two γ quanta is in agreement with the reasoning that η has quantum numbers 0^+. In order to determine the possibility of other γ sources a search was made of resonance states with $x \rightarrow \pi^+ + \pi^- + \gamma$ decay. (R.V.J.)

20935 ON THE PROBABILITY OF DETERMINING π-π SCATTERING PHASES BY ANGULAR CORRELATIONS IN K_{e4} DECAY. E. P. Shabalin (Inst. of Theoretical and Experimental Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 765-7(Feb. 1963). (In Russian)

Data on angular correlations in K_{e4} decay were used in an investigation of π-π interactions in $K^+ \rightarrow \pi^+ + \pi^- + e^+ + \nu$ decay with positron emission asymmetric to the π tracks. The obtained distribution shows the π-π scattering shift in the energy range $2m \leq Q \leq M$ when f_1 and f magnitudes are known. The latter can be found from the π-meson effective mass spectra or the electron energy spectra. An experimental observation of asymmetry is possible when π-π scattering phases in S and P states are different and their contributions are small. (R.V.J.)

20936 ANALYSIS OF STARS CONTAINING HYPERFRAGMENTS PRODUCED BY 9-Bev PROTONS IN PHOTOGRAPHIC EMULSIONS. I. B. Berkovich, A. P. Zhdanov, F. G. Lepekhin, and Z. S. Khokhlova. Zh. Eksperim. i Teor. Fiz., 44: 793-7(Mar. 1963). (In Russian)

Photographic emulsion nuclear disintegrations are studied in which the production of a hypernucleus by 9 Mev protons was established. The fast particles are identified and their momenta are determined. The perpendicular momentum components are 430 ± 140 Mev/c for K mesons and protons and 250 ± 150 Mev/c for π mesons. It is concluded that during hypernuclear formation by protons, Λ^0 particles are mainly produced in the $N + N \rightarrow N + \Lambda^0 + K$ reaction; the Λ^0 particles in the cms move in the backward direction and the K meson and nucleon in the final state may possibly form a bound system that subsequently decays. (auth)

20937 SHAPE OF THE BREMSSTRAHLUNG SPECTRUM NEAR THE HIGH FREQUENCY LIMIT. B. S. Dolbilkin, V. A. Zapevalov, V. I. Korin, and F. A. Nikolaev (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 866-7(Mar. 1963). (In Russian)

The shape of a bremsstrahlung spectrum with an end point energy of 17.15 Mev is investigated with a magnetic pair spectrometer with a resolution ~150 kev near the high frequency limit. It is shown that in the measured energy range the shape of the spectrum can be satisfactorily described by the relation derived by Schiff. (auth)

20938 COULOMB COLLISIONS OF FAST ELECTRONS IN A POLARIZING MEDIUM. V. M. Lenchenko (Inst. of Nuclear Physics, Academy of Sciences, Uzbek SSR). Zh. Eksperim. i Teor. Fiz., 44: 899-902(Mar. 1963). (In Russian)

Formulas for the inelastic scattering effective cross section for electrons in a polarizing medium are derived in the first approximation in quantum perturbation theory. The formulas can be employed for analyzing the characteristic energy losses of electrons in thin films. (auth)

20939 SOME ISOTOPIC RELATIONS FOR REACTIONS INVOLVING FOUR PARTICLES IN THE FINAL STATE. V. A. Valyulka. Zh. Eksperim. i Teor. Fiz., 44: 999-1002 (Mar. 1963). (In Russian)

The relations between the cross sections for reactions involving four particles in the final state are derived under the condition of resonance interaction in the three particle system by assuming charge invariance. Resonances in the $K\bar{K}\pi$, $K\pi\pi$ (or $\bar{K}\pi\pi$) and $K\bar{K}\bar{K}$ systems are considered. (auth)

20940 ROLE OF THE $\gamma + \gamma \rightarrow \gamma + \nu + \bar{\nu}$ PROCESS IN NEUTRINO EMISSION BY STARS. Nguyen Van-Hieu and E. P. Shabalin. Zh. Eksperim. i Teor. Fiz., 44: 1003-7 (Mar. 1963). (In Russian)

The cross section for the reaction $\gamma + \gamma \rightarrow \gamma + \nu + \bar{\nu}$ is calculated and the role of this process in neutrino emission by stars is considered. The magnitude of the neutrino luminosity due to this process is found to be about 10^8 times smaller than the value based on the estimations of Chiu and Morrison. (auth)

20941 REGGE POLES IN NUCLEON-NUCLEON AND NUCLEON-ANTINUCLEON SCATTERING AMPLITUDES. D. V. Volkov and V. N. Gribov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 1068-77(Mar. 1963). (In Russian)

The spin structure and character of the kinematic features of the contributions to the nucleon-nucleon and nucleon-antinucleon scattering amplitude from Regge poles with various quantum numbers are considered. It is shown that the presence of kinematic singularities at $t = 0$ for contributions from certain Regge poles together with the

requirement of analyticity of the whole amplitude leads to the appearance at t = 0 of simple relations between the positions of the Regge poles belonging to different trajectories. The dependence of the forward scattering amplitude on the character of the relations thus obtained is discussed. (auth)

20942 ANALYTIC PROPERTIES OF REGGE POLE TRAJECTORIES. Ya. I. Azimov, A. A. Anselm, and V. M. Shekhter (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 1078-92(Mar. 1963). (In Russian)

The motion of Regge poles for a Yukawa potential at complex energies is studied. It is found that the trajectories have complex (and real) branch points due to collisions of pole pairs. For the case of weak coupling the positions of these points were determined explicitly. The arrangement of the branch points is qualitatively described for stronger coupling. With increase of the coupling constant the branch points leave the physical sheet and consequently the trajectory can lead to the appearance of bound states. (auth)

20943 SCATTERING OF ELECTRONS IN AN EXTERNAL FIELD WITH LARGE MOMENTUM TRANSFER. S. Ya. Guzenko (Inst. of Physics and Tech., Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 1093-8(Mar. 1963). (In Russian)

An asymptotic expression is derived for the scattering cross section of relativistic electrons in an external field. The formula is derived in the single-logarithmic approximation under the assumption that the momentum transferred to the field is large. (auth)

20944 ON THE CROSS SECTIONS FOR ELEMENTARY PROCESSES WITH LARGE ABSORPTION. P. E. Nemirovskii and Yu. P. Elagin. Zh. Eksperim. i Teor. Fiz., 44: 1099-1105(Mar. 1963). (In Russian)

Collisions between nonrelativistic particles accompanied by a large absorption are considered. It is shown that irrespective of the spatial distribution of the absorption the scattering cross section $\sigma_s < \sigma_a$. For absorption, which decreases with the distance according to the laws $\exp(-r^2/b^2)$ or $\exp(-r/c)$, the magnitude of the cross sections weakly depends on the real part of the potential and especially on its behavior at distances that are much smaller than the meson (π) Compton wave length. (auth)

20945 PHASE-SHIFT ANALYSIS OF ELASTIC 660-Mev pp-SCATTERING. R. Ya. Zul'karneev and I. N. Silin (Joint Inst. for Nuclear Studies, Dubna, USSR). Zh. Eksperim. i Teor. Fiz., 44: 1106-10(Mar. 1963). (In Russian)

A phase shift analysis of elastic p-p scattering at an energy of 660 Mev is performed under the assumption that the imaginary part of the scattering phases for the $^3F_{2,3,4}$, and $^1S_0$ states can be neglected. A single phase shift set was obtained. Angular dependences of the differential cross section, polarization, and other parameters calculated on basis of the most probable phase shift set are presented. (auth)

20946 EXCITATION OF PHONONS IN LIQUIDS AND CRYSTALS THROUGH GAMMA-RAY SCATTERING. Roger Bryant De Bar. Thesis, Stanford, Calif., Stanford Univ., 1962. 113p.

Gamma-ray scattering is considered as a means of obtaining information about collective excitations in simple crystals, liquid helium II, and certain nearly classical fluids. The energy transfer dependent differential cross section for the almost elastic scattering of gamma rays from an assembly of atoms (assumed for simplicity to be of the same kind) is derived from first principles and is found to be proportional to the Fourier transform of the correlation kernel obtained by Zemach and Glauber and Van Hove in connection with similar studies for the case of cold neutron scattering. Through a straightforward quantization of the classical velocity potential, a plausible expression is obtained for the differential cross section in the case of liquid helium II. This result indicates the general form of the energy transfer dependent scattering cross section and enables one to estimate the intensity of the scattering at the energy transfer values corresponding to the creation or annihilation of collective excitations. A similar result is obtained for simple crystals, using the quantized harmonic oscillator representation for the time-dependent atomic position vectors. A convenient and fairly general expression is given for the contribution to the coherent scattering cross section corresponding to single-phonon interactions, and the background produced by multiple-phonon interactions and umklapp effects is considered in detail. Incoherent scattering from nearly classical fluids is investigated using the dispersion relations obtained by Schofield together with Vineyard's assumption of a Gaussian form for the self-correlation function governing the single-atom scattering processes. Approximation techniques for obtaining quantum-mechanical corrections to the classical representations for the self-correlation function are considered, and an approach is found which appears somewhat better than other proposals which have been advanced. Other results of interest include a derivation of criteria for the goodness of Vineyard's Gaussian approximation for the self-correlation function together with an extremely simple expression for its most general form, and a discussion of the Bloch Theorem concerning the expectation values of exponentials of quantities having a Gaussian distribution function. (Dissertation Abstr. XXIII, No. 8)

20947 STUDY OF PION-HYPERON RESONANCES IN DISPERSION RELATIONS IN THE UNPHYSICAL SHEET. Rudolph Chia-Chao Hwa. Thesis, Providence, Brown Univ., 1962. 181p.

A method has been developed for studying resonances in elementary particle physics. The S-matrix approach is used to investigate the dynamics of the interactions, and the Mandelstam representation is used to determine the locations of the singularities in the complex energy plane for the partial-wave scattering amplitudes. Those unphysical singularities that are near the physical region can be calculated in terms of the coupling constants, but the ones that are faraway are unknown. The effects of these faraway singularities are taken into account by inserting a conjugate pair of resonance poles in that unphysical Riemann sheet which is reached by continuation across the physical section of the unitarity cut. The theory involves the use of one parameter, the real part of the locations of the complex poles which, for a narrow resonance, corresponds to the experimental resonance position. The imaginary part, being a measure of the resonance width, is related to the long-range part of the interaction and therefore to the nearby singularities. Taking only these known singularities into consideration, the dispersion relations are used in the unphysical sheet to establish a constraint on the imaginary part of the resonance-pole positions. The formalism is built to treat multi-channel two-particle systems. It is shown that the S matrix in the angular-momentum representation can be diagonalized by a real orthogonal transformation in the physical region of all channels under consideration. The analytic properties of the eigenamplitudes are examined in detail. To illustrate the calculational procedure, the pion-hyperon resonance in the I = 1 state, Y_1^* is considered taking the $\Lambda\Sigma$ relative parity to be either even or odd. It is also

concluded that there are no basic differences between a dynamical resonance and an unstable bound state. (A.G.W.)

20948 SOME CORRECTIONS TO PARTIAL WAVE DISPERSION RELATIONS FOR PION PHOTOPRODUCTION. John McKeen McKinley. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 159p.

The exact one-dimensional dispersion relations for partial wave amplitudes of pion-nucleon scattering and of pion photoproduction on nucleons were derived and compared. It was found that a non-constant comparison function must be introduced into the relationship between the scattering partial wave amplitude which is dominant at low energies and the corresponding photoproduction partial wave amplitude, in order that each amplitude obey its own exact dispersion relation at the same time that the two amplitudes are related by the unitarity condition. The results of experimental determinations of pion-nucleon scattering phase shifts were compiled, and the coefficients of interpolation formulae for the phase shifts were evaluated. The experimental results of photoproduction of neutral and of positive pions on protons at energies up to 500 Mev were compared to calculated cross sections for various combinations of choice of phase shifts and inclusion of the comparison function. The photoproduction cross sections were also calculated with the inclusion of the contribution of the "bipion." The effect of this contribution was generally greater than the effect of either the comparison function or a change of phase shifts. On the basis of the π^+ angular distribution it appeared that the coupling parameter for this contribution should be negative. (Dissertation Abstr. XXIII, No. 8)

20949 SIGMA-LAMBDA CONVERSION AND ELASTIC LAMBDA-PROTON SCATTERING. Robert James Oakes. Thesis, Minneapolis, Univ. of Minnesota, 1962. 88p.

Each of 6 previously made proposals for determining the relative lambda-sigma parity is discussed in some detail and the relevant data, or the lack of it, is reviewed. The reasons why none of these proposals has been completely successful to present are given. It is proposed that a study of production reactions of the type $\Lambda + N \rightarrow \Sigma + N + \pi$ and $\Sigma + N \rightarrow \Lambda + N + \pi$ at high energies and low momentum transfers could provide the information necessary to determine the lambda-sigma parity. The analysis of these reactions is performed within the framework of the one-pion-exchange or peripheral collision model. Arguments are given for the applicability of this model at high energies and low momentum transfers. The analysis shows how the differential cross sections and polarizations depend on the lambda-sigma parity and how this parity can be inferred from cross section and polarization data. Numerical calculations are given for the reactions $\Sigma^+ + p \rightarrow p + \pi^+$ and $\Lambda + p \rightarrow \Sigma^- + p + \pi^+$ at total center of mass energies of 2.28 and 2.70 Bev, respectively. On the basis of the numerical work, it is concluded that it is feasible to observe events of the type $\Lambda + N \rightarrow \Sigma + N + \pi$ and $\Sigma + N \rightarrow \Lambda + N + \pi$ in liquid hydrogen in spite of the competition from hyperon decay, provided the energy is sufficiently high. Finally, the Λ elastic scattering cross section has been calculated under the assumption that the scattering is dominated by the exchange of mesons in a resonant state. Those resonances whose exchange conserves isotopic spin are the 550-Mev 3π resonance (η), the 785-Mev 3π resonance (ω), and the 885 π K resonance (K'). We suppose the η to be coupled to the hypercharge current and consequently ignore it. Since the angular momentum of the πK resonance has not been determined, we consider both possibilities: either vector (K') or scalar (K*). We find the few data can be fit by the coherent exchanges of either ω and K' or ω and K* with reasonable coupling constants. In comparison the one-kaon-exchange contribution is negligible, provided the coupling constant satisfies $0 \leq G^2_{KAN}/4\pi \leq 3$. An estimate of the coupling constant $G^2_{K'AN}/4\pi$ is made which is compatible (incompatible) with a previous independent estimate, provided the πK resonance is vector (scalar). This result provides corroborating evidence in favor of the spin one assignment to the πK resonance. (Dissertation Abstr. XXIII, No. 8)

20950 STATISTICAL MECHANICS OF ASSEMBLIES OF CHARGED PARTICLES. Barry William Ninham. Thesis, College Park, Md., Univ. of Maryland, 1962. 192p.

A theory developed by Montroll and Ward for dealing with the quantum statistics of interacting particles is extended, and the relations between this theory and several others in use for the same problem are elucidated. The theory is then applied to the calculation of some thermodynamic functions of an electron gas. For the low temperature specific heat of an electron gas the method yields a result identical analytically with that obtained by Du Bois, who used a different approach. The numerical evaluation of this result carried out by Du Bois is shown to contain errors, and his value for the specific heat has been corrected. The first quantum corrections to the Debye-Huckel formula for the equation of state of a low-density high-temperature ionized gas are computed, and it is shown that for the corresponding relativistic gas there are no corrections to the classical Debye-Huckel formula. Finally the method is applied to the investigation of a possible Bose-Einstein condensation in a gas of charged bosons and fermions. (Dissertation Abstr. XXIII, No. 8)

20951 INTERNAL CONVERSION OF GAMMA RAYS. M. A. Listengarten. p.271-507 of "Gamma-Luchi." Moscow-Leningrad, Publishing House of the Academy of Sciences, 1961.

The present state of the internal conversion theory of γ rays is reviewed. The detailed derivation of formulas for the internal conversion coefficient is given. The effect of nuclear finite dimensions and shielding is taken into account. Circumstantial tables for the internal conversion coefficient on K and L shells are appended. (P.C.H.)

20952 CIRCULAR POLARIZATION OF GAMMA RAYS FROM NEUTRAL PARTICLE DECAYS. Haakon Olsen (Norges Tekniske Høgskole, Trondheim, Norway). Preprint No. 1, 11p.

Paper from Proceedings of the Physics Seminar in Trondheim, 1962.

Measurement of the circular polarization of high energy gamma rays from the decay of neutral elementary particles provides information concerning the polarization and decay properties of these particles. The use of pair production for measuring the circular polarization of high energy photons is discussed. This method has a large efficiency since both the cross section for pair production and its polarization dependence are large. The method uses the correlation between the circular polarization of the gamma ray and the direction of motion of the pair particles. Possible experiments to which this method may be applied are discussed. (C.E.S.)

20953 A STUDY IN KEMMER-ALGEBRA AND FOLDY-WOUTHUYSEN TRANSFORMATIONS FOR PARTICLES WITH SPIN 0 AND 1. H. Hoegasen. Preprint No. 2. 60p.

Paper from Proceedings of the Physics Seminar in Trondheim, 1962.

The theory for particles with spin 0 and 1 is developed. A review of Kemmer algebra is given that includes the

basis of the wave function for the particles. The wave equations and transformed wave equations for particles with spin 0 and 1 are presented. It is also shown that the transformation to the Foldy–Wouthuysen representation can be performed by an Eriksen type of transformation. (C.E.S.)

20954 MEASUREMENT OF THE HELICITY OF BREMSSTRAHLUNG FROM β-RAYS BY THE TRANSMISSION METHOD. K. Budal and K. Loenvik (Inst. of Physics, N.T.H., Trondheim, Norway). Preprint No. 7. 16p.

Paper from Proceedings of the Physics Seminar in Trondheim, 1962.

Experimental results of measurements on the circular polarization of bremsstrahlung from Y^{90} performed with a transmission type polarimeter are presented. The bremsstrahlung was produced by stopping the β particles from Y^{90} in thick targets of Al and Pb. (C.E.S.)

Neutron Physics

20955 (AAEC/E-103) A DIFFERENTIAL EQUATION FROM THE THEORY OF NEUTRON THERMALISATION. F. J. Wade (Australia. Atomic Energy Commission Research Establishment, Lucas Heights, New South Wales). Feb. 1963. 23p.

The heavy gas model using a synthetic kernel leads to coupled equations for the determination of the neutron flux in a bare reactor. The very special problem of solving analytically the defining equation for the energy dependent neutron flux in a region for which there are no source terms is considered. (auth)

20956 (GEAP-4018) THERMAL NEUTRON DIFFUSION LENGTH MEASUREMENTS IN LIGHT WATER FROM 20°C TO 90°C. J. L. Russell, Jr., W. C. Ballowe, W. R. Morgan, and W. V. Mosgovoy (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Apr. 1962. Contract AT(04-3)-189. 23p.

The diffusion length of thermal neutrons in light water was measured as a function of temperature in the range 20 to 90°C for both pure water and poison solutions. Various concentrations of three poisons — H_3BO_3, $CdSO_4$, and $Gd(NO_3)_3$ — were used in this experiment. The thermal neutron source was the thermal column of the General Electric Nuclear Test Reactor. The "Water Gun" apparatus was utilized for the measurements. (auth)

20957 (LA-2834) APPROXIMATE MODELS FOR THERMALIZATION IN SOLIDS. K. D. Lathrop (Los Alamos Scientific Lab., N. Mex.). Sept. 1962. Contract W-7405-eng-36. 55p.

To describe neutron thermalization in solids it is postulated that chemical binding effects can be represented by an atom speed distribution and a free particle neutron-atom interaction. Three atom speed distributions prepared from elementary atomic models are used with the Wigner-Wilkins formalism to prepare the scattering terms of the neutron thermalization balance equation for an infinite medium. The resulting equations are solved numerically. Where possible, numerical solutions are compared with analytic solutions. Asymptotic solutions for large neutron energy are found to agree with those derived by Corngold. Numerical solutions for equations describing thermalization by single energy hydrogen classical harmonic oscillators agree well with experimental results for thermalization in zirconium hydride, but the choice of parameters used to obtain agreement is somewhat arbitrary. (auth)

20958 (LAMS-2873) ANISOTROPIC SCATTERING IN THE TRANSPORT EQUATION. AN EVALUATION OF COMMON APPROXIMATIONS. K. D. Lathrop (Los Alamos Scientific Lab., N. Mex.). Mar. 1, 1963. Contract W-7405-eng-36. 35p.

In the monoenergetic transport equation, the infinite medium diffusion length is calculated for ratios of the mean number of secondaries per collision less than unity. The diffusion length is calculated using several common approximations to scattering laws which attempt to account for anisotropic scattering. Results of these calculations are compared to direct solutions of the transport equation obtained using the exact scattering law for elastic scattering by hydrogen and a three term expansion in inverse powers of the atom mass for deuterium elastic scattering. In addition to common anisotropic scattering approximations, a step function approximation is developed and examined. A variational expression is derived for the diffusion length which appears as an eigenvalue in the transport equation. A quadratic trial function is found to provide an upper bound for the values of the eigenvalue and to give approximate expressions that are improvements over the usual small absorption expansions. Accuracy of the various approximations for calculating the infinite medium diffusion length and for describing hydrogen elastic scattering is compared. (auth)

20959 (UNC-5043) AN IBM-7090 MONTE CARLO PROGRAM TO CALCULATE NEUTRON TRANSPORT IN CYLINDRICALLY SYMMETRIC SHIELDS WITH PARTICULAR EMPHASIS ON NEUTRON HEATING IN LIQUID HYDROGEN. G. Rabinowitz, F. Maimborg, and M. Shapiro (United Nuclear Corp. Development Div., White Plains, N. Y.). Nov. 1, 1962. Contract SNPC-5. 65p.

An IBM-7090 Monte Carlo program (UNC-90-5) was written to calculate neutron transport in cylindrically symmetric NERVA configurations with particular emphasis on the heating produced by neutron interactions in liquid hydrogen. A homogenized reactor provides the radiation source, and a shield exists between the fuel tank and the reactor. The assemblage is assumed to be in a vacuum. Special edits were prepared to evaluate from the results of the main program: fast neutron dose for near axis points, the spatial distribution of neutron captures in hydrogen, and the angle-energy distribution of particles passing through specified planes of the configuration. (auth)

20960 A PROBLEM OF NEUTRON TRANSPORT WITHIN A SPHERICAL MEDIUM. Pier Paolo Abbati Marescotti (Università, Bologna). Atti Accad. Sci. Torino, Pt. I, Classe Sci. Fis., Mat. Nat., 97: 87-102(1962-63). (In Italian)

The distribution function and the neutron source term in a homogeneous sphere were determined. The distribution function of neutrons leaving the surface was also considered. (tr-auth)

20961 NOTE ON SPECTRUM HARDENING FOR NON 1/v CROSS SECTIONS. W. Clendenin (Westinghouse Electric Corp., Pittsburgh). Nucl. Sci. Eng., 15: 1p.(Feb. 1963). (WAPD-T-1524)

The range in which the moderator scattering kernel is most important is examined. Spectra and macroscopic absorption cross sections were obtained using the free proton model and Nelkin model and various source spectra. Results show that the spectra for non-1/v cross sections are sensitive to the source term and indicate that for non-1/v absorbers the kernel for incident neutron energies of 0.625 ev and greater is significant. (D.C.W.)

20962 THE SCATTERING OF LONG WAVELENGTH NEUTRONS BY IRRADIATED BERYLLIUM OXIDE. T. M. Sabine, A. W. Pryor, and B. S. Hickman (Australian Atomic Energy Commission Research Establishment, Sydney). Phil. Mag. (8), 8: 43-57(Jan. 1963).

The scattering of long-wavelength neutrons by polycrystalline beryllium oxide irradiated to integrated fission neutron doses between 2.5×10^{19} and 6.8×10^{20} at temperatures of 75 to 100°C was investigated. A considerable amount of extra scattering is introduced by irradiation, and this scattering has a strong wavelength dependence. The extra scattering is interpreted in terms of scattering from defects. A model in which the defects are present in the form of clusters containing a minimum of 10 to 20 interstitials or vacancies and the other half are randomly distributed describes very closely the experimentally observed wavelength dependence of the scattering. Based on this model, calculations were made of the total number of defects present in the irradiated material, and it is shown that each primary knock-on results in about 10 to 20 displaced atoms. The effect on the proposed model of a dilatation around the defects is discussed, and it is shown that provided a reasonable figure is chosen for the dilatation, the results are not significantly affected. Annealing studies show that the defects anneal in the temperature range 800 to 1400°C. (auth)

20963 NEUTRON SPIN-NEUTRON ORBIT INTERACTION WITH SLOW NEUTRONS. C. G. Shull (Massachusetts Inst. of Tech., Cambridge). Phys. Rev. Letters, 10: 297-8 (Apr. 1, 1963).

Measurements were made of the polarization ratio of the scattered intensities for the two neutron spin states for two reflections (110) and (220) for positive angles and for the reflection (110) at negative angles. Very high neutron polarization was available and the intensity was studied as the magnetic field on the crystal was reduced to zero so as to avoid any electronic polarization scattering. Crystals of vanadium, silicon, and sodium chloride were used. (C.E.S.)

20964 THE SCATTERING OF SLOW NEUTRONS BY HEAVY WATER. I. INTRAMOLECULAR SCATTERING. D. Butler (English Electric Co. Ltd., Whetstone, Leics, Eng.). Proc. Phys. Soc. (London), 81: 276-93(Feb. 1, 1963).

A model for neutron scattering by heavy water is presented and calculations of total neutron scattering cross section based on the model show quite good agreement with experiment. Interference scattering between any two atoms of the same molecule is included and shown to be important in determining the angular distribution of scattered neutrons. The theory gives the scattering law from which the neutron spectrum in a reactor system may be determined, and there is good agreement with the experimentally determined scattering law. (auth)

20965 THE SCATTERING OF SLOW NEUTRONS BY HEAVY WATER. II. INTERMOLECULAR SCATTERING. D. Butler (English Electric Co. Ltd., Whetstone, Leics, Eng.). Proc. Phys. Soc. (London), 81: 294-9(Feb. 1, 1963).

A simple model is proposed for intermolecular interference scattering of neutrons in heavy water. The theory supplements that given by Butler in the accompanying paper, correctly predicting the existence and position of the diffraction peak in the angular distribution of scattered neutrons, and improving the agreement between the calculated and experimental values of the total cross section. It is shown that the integrated quantities, total cross section and $\bar{\mu}$, can be well estimated by ignoring both intermolecular and intramolecular interference scattering since the one nearly cancels out the other. (auth)

20966 EFFECT OF CAVITIES ON NEUTRON DIFFUSION. Richard Ni-chong Hwang. Thesis, Ames, Iowa, Iowa State Univ. of Science and Tech., 1962. 125p.

Expressions are obtained for the neutron flux within and on the boundary of an isolated cavity of spherical and cylindrical shapes. Analytic solutions are also obtained for the flux distribution in the surrounding medium of the finite and infinite extent with an isotropic plane source. The behavior of neutrons in the cavity is described by the continuity equation, which can be reduced to the Laplace equation if the scattering is isotropic throughout the surrounding system. So long as the neutron flux varies slowly in space, the diffusion theory is assumed to be valid everywhere in the surrounding medium including boundary points. The discussion of the validity of the diffusion theory is also given. The results have shown that the neutron flux in a medium containing a uniform plane source will, in general, be increased by the presence of a cavity. This increase is significant only within and near the vicinity of the cavity. An investigation of the effect of cavities on fast neutrons is also included. Expressions for the slowing down density of a system with a cavity are the inverse Laplace transforms of the neutron flux with respect to k^2. (Dissertation Abstr. XXIII, No. 8)

20967 INELASTIC SCATTERING OF NEUTRONS IN SOLIDS AND LIQUIDS. VOL. II. Proceedings of the Symposium held at Chalk River, Canada, September 10-14, 1962. (International Atomic Energy Agency, Vienna). Proceedings Series. Jan. 1963. 352p. (STI/PUB/62 (Vol. II)). $7.00; 147s; NF 28; DM 24.50(IAEA).

Twenty-nine papers on inelastic neutron scattering by liquids and solids (some, magnetic) are included. Abstracts were prepared for 12 papers; 17 were previously abstracted in NSA. (D.C.W.)

20968 THE DISTRIBUTION OF HIGHER ENERGY NORMAL MODES IN DIAMOND. E. W. J. Mitchell (Reading Univ., Eng.), J. R. Hardy, and D. H. Saunderson. p.49-54 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The beryllium detector method was used to measure the spectrum of neutrons scattered inelastically by polycrystalline sample of diamond at room temperature. The results are used to derive the phonon frequency distribution in the modes between 0.11 and 0.17 ev by a method based on the analysis described by Egelstaff and Cocking. Peaks in the distribution are compared with the results of previous measurements of the 2-phonon spectrum by infrared spectroscopy. (auth)

20969 THE FREQUENCIES OF THE NORMAL MODES OF ALUMINIUM. G. L. Squires (Cambridge Univ., Eng.). p.55-69 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The results of Larsson, Dahlborg and Holmryd, who measured the frequencies of about 300 normal modes of aluminum in the 001 symmetry plane, were analysed on the basis of the Born-von Kármán theory of lattice vibrations. The calculation shows that at least seventh neighbour forces are necessary in order to fit the data. Each time the model is extended to take account of forces due to the next set of neighbours, the values of the previously determined force

constants change appreciably. The values finally obtained are therefore of doubtful significance. (auth)

20970 THE RELATION BETWEEN THE INTERATOMIC FORCES AND THE FREQUENCIES OF SYMMETRY PHONONS IN CUBIC CRYSTALS. G. L. Squires (Cambridge Univ., Eng.). p.71-86 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

Measurements of the frequencies of normal modes in a crystal are often made for phonons whose wave vectors have some special symmetry position in the reciprocal lattice. The extent to which the interatomic force constants can be determined from such measurements was investigated for face-centred and body-centred cubic crystals. (auth)

20971 DISPERSION RELATIONS FOR PHONONS IN MAGNESIUM. P. K. Iyengar, G. Venkataraman, K. R. Rao, P. R. Vijayaraghavan, and A. P. Roy (Atomic Energy Establishment, Trombay, India). p.99-110 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The dispersion relation for acoustic phonons whose wave vectors lie in the basal plane were measured by neutron spectrometry. A triple axis spectrometer was used both in the conventional method and 'constant Q' method. The results are compared with calculations based on two-neighbour central forces. (auth)

20972 THE PHONON FREQUENCY DISTRIBUTION OF VANADIUM. R. Haas, W. Kley, K. H. Krebs, and R. Rubin (EURATOM, CCR, Ispra, Italy). p.145-54 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The inelastic scattering of vanadium was measured by the beryllium filter time-of-flight method. The resolution of the instrument is about 20 μsec/m at the beryllium cut-off with a flight path length of 5.5 m. Besides the usual corrections the measurements were corrected also for the resolution and for the incident spectrum. The vibrational frequency spectrum derived from the scattering data is qualitatively in agreement with earlier measurements. However, the spectrum extends to higher frequencies than was assumed previously. A comparison was made with theoretical spectra based on models given by Fine, De Launay and Bhatia. The best agreement is found for the last model. (auth)

20973 OBSERVATION OF A LOW ENERGY PEAK IN THE PHONON FREQUENCY DISTRIBUTION OF VANADIUM. L. Pelah, R. Haas, W. Kley, K. H. Krebs, J. Peretti, and R. Rubin (EURATOM, Ispra, Italy). p.155-8 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

A low energy peak was observed in the frequency distribution of vanadium at a phonon energy of (8 ± 1) Mev. This peak can be explained with regard to its energy value and magnitude as a "Kohn Effect." (auth)

20974 FREQUENCY OF OPTICAL VIBRATIONS IN FLUORITE (CaF_2). D. Cribier, B. Farnoux, and B. Jacrot (Centre d'Études Nucléaires, Saclay, France). p.225-8 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

The optical vibration frequencies of fluorite were measured. Particular attention was paid to determining the frequencies at $q \simeq 0$. The use of a time-of-flight basis of 8.30 m and a resolution of 6 μsec/m permitted the frequencies to be determined to an accuracy of 1%. The findings were as follows: Raman frequency $\nu_R = 9.66 \times 10^{12}$ c/sec; infra-red absorption frequency (transverse vibration) $\nu_T = 7.75 \times 10^{12}$ c/sec; longitudinal infra-red frequency $\nu_L = 14.36 \times 10^{12}$ c/sec. Within experimental errors, the Lyddane-Sachs-Teller correlation was verified. (auth)

20975 STUDY OF AMMONIUM HALIDES BY NEUTRON SPECTROMETRY. G. Venkataraman, K. Usha, P. K. Iyengar, P. R. Vijayaraghavan, and A. P. Roy (Atomic Energy Establishment, Trombay, India). p.253-63 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The scattering of slow neutrons from the ammonium halides NH_4Cl, ND_4Cl, and NH_4Br was studied at several temperatures with a view to elucidate the nature of the specific heat anomaly associated with these substances. According to Pauling the anomaly is due to the onset of free rotation of the ammonium ion, whereas according to Frenkel the anomaly is due to an order-disorder process. The present measurements rule out the possibility of free rotation thus confirming the Frenkel hypothesis. Values of the torsional frequencies and barrier heights for rotation were derived and the relation of neutron scattering data to infra-red absorption. Raman scattering and nuclear magnetic resonance results are discussed. (auth)

20976 LOW FREQUENCY HYDROGEN VIBRATIONS IN POTASSIUM DIHYDROGEN PHOSPHATE. H. Palevsky, K. Otnes, and Y. Wakuta (Brookhaven National Lab., Upton, N. Y.). p.273-80 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The BNL cold neutron facility was used to investigate the low energy states in KH_2PO_4 and KD_2PO_4 at room temperature and below the transition temperature. The energy interval covered ($8 - 170 \times 10^{-3}$ ev) corresponds to wave numbers of $25 - 1300$ cm^{-1}, a region which is difficult to investigate by infrared absorption techniques. At very low energies broad peaks corresponding to the acoustic modes of the crystal are observed; at the high energy end the vibrations characteristic of the PO_4 molecule are found. The excitation modes associated with hydrogen are identified by the change in scattering intensity with deuteration. By this means, it is shown that a band of frequencies centered around 180 cm^{-1} is associated with hydrogen vibrations. The spectra for both KH_2PO_4 and KD_2PO_4 below their ferroelectric transition temperatures was found to have the same general shape as their corresponding room temperature data, the major changes in shape being accounted for by the Boltzman population factor. A comparison of these inelastic neutron scattering results with those obtained from neutron diffraction and infrared measurements is discussed. (auth)

20977 ENERGY DISTRIBUTION OF NEUTRONS SCATTERED FROM SOLID METHANE. H. Stiller (Kernforschungsanlage, Jülich, Ger.) and S. Hautecler. p.281-93 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In English)

The energy distributions of neutrons scattered from solid methane at 84 and 18°K are measured with the beryllium filter technique for incident neutron energies between 23 and 5.2 mev. The observed spectrum is interpreted as due to excitation of lattice vibrations and of rotational motions. The spectrum of lattice vibrations at 18°K can be best explained under assumption of attractive Van der Waal forces

and repulsive octopol-octopol interaction. The rotational motions are found to be completely hindered at 18°K, giving rise to two bands of frequencies of "torsional waves." This distribution is compared to two models for the equilibrium orientation of the molecules. At 84°K lattice vibrations and rotational motions appear less well separated. (auth)

20978 SCATTERING BY MnF_2 IN THE PARAMAGNETIC STATE. D. Cribier and B. Jacrot (Centre d'Études Nucléaires, Saclay, France). p.309-15 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

Small-angle scattering (< 30°) gives a line that grows in width with the scattering angle. At large angles, the width is constant and the line is Gaussian. From its width, the exchange integrals in MnF_2 were measured. (auth)

20979 SMALL-ANGLE SCATTERING OF NEUTRONS BY IRON AND NICKEL CLOSE TO THE CURIE POINT. B. Jacrot, J. Konstantinovic, G. Parette, and D. Cribier (Centre d'Etudes Nucléaires, Saclay, France). p.317-26 of "Inelastic Scattering of Neutrons in Solids and Liquids. Vol. II." Vienna, International Atomic Energy Agency, 1963. (In French)

Recent studies on critical scattering by iron have thrown fresh light on the results obtained previously and shown that at the Curie point, scattering is inelastic. The Lorentzian form of the lines and their angular dependence establish the existence of a scattering process having the diffusion coefficient $2m\ \Omega/\hbar = 7$. At the Curie point, the coefficient K_1^2 is less than $5 \times 10^{-5}\ A^{-2}$. Iron and nickel have very different angular distribution. Small-angle scattering below T_c was also studied. (auth)

Nuclear Properties and Reactions

Refer also to abstract 20055.

20980 (CEA-2228) ETUDE DES FLUCTUATIONS DES LARGEURS PARTIELLES DE CAPTURE RADIATIVE DU ^{232}Th. (Study of Partial Width Fluctuations for Th^{232} Radiative Capture). H. Nifenecker, Y. Hazoni, A. Michaudon, and D. Paya (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 14p.

The partial widths of radiative capture at the excited level at 1 Mev in Th^{233} were measured. This measurement was achieved on 7 neutron resonances of Th^{232} from 20 to 175 ev. The normalization methods used for deducing these widths are described. The most probable value of the number of degrees of freedom is found to be 4 and the probability that $\nu \leq 1$ is found to be 16 per cent. (auth)

20981 (HW-75806) THE QUANTITATIVE ANALYSIS OF SETS OF MULTICOMPONENT TIME DEPENDENT SPECTRA FROM DECAY OF RADIONUCLIDES. W. L. Nicholson, J. E. Schlosser, and F. P. Brauer (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Dec. 1962. Contract AT(45-1)-1350. 114p.

With a set of spectra three methods are offered to eliminate background. A detailed description and listing is included of an IBM FORTRAN language program (suitable for a machine of memory capacity 32K) that performs the weighted least squares estimation. As a degenerate case the program performs the simultaneous linear estimation also. Examples are included of the application of the program to both actual pulse-height spectra and to Monte Carlo generated spectra. The data processing system for transfer of punch paper tape multichannel data to magnetic tape and for input-output to the quantitative analysis program is also described. (auth)

20982 (HW-SA-2875) FAST-NEUTRON TOTAL CROSS SECTIONS OF 44 ELEMENTS. D. W. Glasgow and D. G. Foster (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Apr. 9, 1963. Contract AT (45-1)-1350. 10p.

Fast neutrons from the $Li^7(d,n)Be^8$ reaction were used to measure the neutron total cross sections of 20 elements that have principal isotopes with magic neutron numbers and to remeasure the cross sections of 25 other elements. Neutron energies from 3 to 15 Mev were determined by the pulsed-beam time-of-flight technique. A Fortran program for the Hanford IBM 7090 was used to calculate the cross sections. Ramsauer structure in the twenty cross sections shows a reasonable continuity with those for the remeasured cross sections. Closed neutron shells, particularly for magic numbers greater than 28, introduce small but distinct anomalies; but closed proton shells produce anomalies only if they are combined with a closed neutron shell. Unresolved anomalies appeared in As and Sr. (D.C.W.

20983 (IA-755) THE REACTIONS $O^{17}(n,p)N^{17}$ AND $O^{18}(n,d)N^{17}$ WITH REACTOR NEUTRONS. S. Amiel and J. Gilat (Israel. Atomic Energy Commission, Rehovoth). Feb. 1963. 20p.

The reaction $O^{17}(n,p)$ and the previously unreported reaction $O^{18}(n,d)$ were found to be responsible for the production of the 4.14-second delayed neutron precursor, nitrogen-17, in water irradiated in a nuclear reactor. The effective cross sections of these reactions with fission spectrum neutrons were measured by counting the delayed neutron emission of irradiated water samples enriched with oxygen-17 and 18. The values obtained were 7.4 ± 0.6 and 0.086 ± 0.008 μb, respectively. (auth)

20984 (JINR-P-1178) ISSLEDOVANIE RASPADA $Dy^{155} \rightarrow Tb^{155}$. (An Investigation of $Dy^{155} \rightarrow Tb^{155}$ Decay). Ya. Urbanets, Ya. Kaifosh, J. Zovlskii, and A. Novgorodov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Nuclear Problems). 1963. 10p.

The γ spectrum and coincidences of γ rays appearing in $Dy^{155} \rightarrow Tb^{155}$ decay were measured with the aid of a scintillation γ spectrometer. A pure source with only one isotope of Dy^{155} was used in the measurements. It was obtained by a repeated chromatographic separation from Ho fraction produced by a deep fission reaction on Ta: (Ta + p), E = 660 Mev. Dy^{155} appears as a decay product of Ho^{155} ($T_{\frac{1}{2}}$ = 45 min). In the γ spectrum new lines in the energy range of 1170–2000 kev were observed. As a result of γ-γ coincidence measurements a new level (1820 ± 15/kev) of Tb^{155} was obtained. (auth)

20985 (JINR-P-1187) CHASTICHNO PROEKTIROVANNYE FUNKTSII V SVERKHTEKUCHEI MODELI YADRA. (Partially Projected Functions in a Superfluid Nuclear Model). I. N. Mikhailov (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Theoretical Physics). 1963. 9p.

A new set of trial functions is suggested for solving variational problems arising in the superfluid model of a nucleus. These functions satisfy additional invariance conditions that follow from the particle number conservation law. From another point of view the new functions contain only a small part of those superfluous components that are present in standard functions. The properties of the new functions are investigated. The energy of a system

in the state described by the function that satisfies the stationarity condition is found. (auth)

20986 (JINR-P-1197) ISSLEDOVANIE UGLOVYKH RASPREDELENII REAKTSII He^3 + T. (Investigation of Angular Distributions of the He^3 + T Reaction). B. Kyun and B. Schlenk (Joint Inst. for Nuclear Research, Dubna, U.S.S.R. Lab. of Neutron Physics). 1963. 15p.

The angular distributions of charged particles were measured for all the channels of the He^3 + T reaction at the following incident triton energies: 460, 665, 900, and 1087 kev. The form of the distributions obtained is not isotropic and varies with energy. From the angular distributions and relations between the reaction channels, the total reaction cross sections and the cross sections for each individual channel were obtained. (auth)

20987 (LA-2805) THE TWO-BODY t-MATRIX FOR A FREE-BOUND SYSTEM. PART I. APPLICATION TO NUCLEAR CHARGE EXCHANGE. James E. Young (Los Alamos Scientific Lab., N. Mex.). July 1962. Contract W-7405-eng-36. 123p.

The nuclear charge exchange $X(_zA_{n\ t\ b-1}\ A_{n+1})Y$ can be reduced in a fully antisymmetrized description to one of elementary nature, $n + p \rightarrow n' + p'$. The t-matrix for the latter has to be averaged over the momenta distribution of the bound constituents. For sufficiently large bombarding energies and small Q values, the nucleon carried by the incident system may be considered as quasi-free. That carried by the outgoing system is then described in a similar fashion. This sort of approximation is consistent with the determination of t from an equation of the Bethe-Goldstone type. Solutions of this equation are sought which apply to the finite nucleus. One of the nuclear constituents is viewed as being in continuum states, the other in bound states. The application of the development to $Be^9(He^3,T)B^9$ is solely for the purpose of concreteness. A major aspect of the analysis is that the virtual excited states of the intermediate system are taken into account. This is done by making specific assumptions concerning the single particle transitions brought about by the addition of a nucleon to the target nucleus. The possibility of a collective intermediate state excitation is considered. This is described through the introduction of a continuum two-particle bound state. Such a state gives rise to the principal renormalization of the two-particle transition operator. The final form of the elementary transition operator is one having a single-particle spectrum of excitations, renormalized by the coupling to the collective state. The transition operator is additive and can be classified both as to diagonality of its matrix elements and according to the resonance structure of these. In its form as a sum of diagonal and non-diagonal operators, the former is responsible for nuclear distortions, the latter for the physical change of state. It is the non-diagonal operator which determines the direct interaction processes. It, in particular, induces changes of state for just a few target constituents. The diagonal part of the interaction operator is moreover expressible as a sum of resonant and non-resonant terms. These are, respectively, contributions arising from the continuum bound state and those described as potential scattering. The latter again include virtual transitions of the interacting constituents. Emphasis is put upon viewing the reaction problem in terms of the self-consistency requirements of the H-F method. This, together with procedures arising out of Brueckner theory, leads to the characterization of the interaction dynamics. (auth)

20988 (NYO-10173) RESEARCH IN ACTIVATION ANALYSIS. Quarterly Progress Report, December 1962–February 1963. Henry H. Kramer, Victor J. Molinski, and Werner H. Wahl (Union Carbide Nuclear Co. Research Center, Tuxedo, N. Y.). Mar. 29, 1963. Contract AT(30-1)-2975. 24p.

Studies completed on rapid radiochemical separations and metastable isomeric states of use in activation analysis are described. A rapid chemical procedure was developed for the radiochemical isolation of 2.3-min Al^{28} from neutron-irradiated samples of ore materials. The procedure involves the separation of soluble sodium aluminate from the aqueous dissolution of a sodium peroxide fusion mass followed by the precipitation of the Al as the hydroxide. The radiochemical separation of Al from ore samples required from 5 to 7 min with gravimetrically determined chemical yields of 50 to 80%. In the area of metastable isomers, studies of 48.6-min Cd^{111m}, 2.6-min Ba^{137m}, and 2.88-hr Sr^{87m} showed that these species are generally the most sensitive indicators for the activation analysis of the respective elements. In each case the isomer can be produced by inelastic neutron scattering and/or photoexcitation of the stable ground state isotope and by radiative neutron capture, as well as by an (n,2n) reaction on the neighboring stable isotopes. The relative importance of the reactions for the production of the isomers was evaluated by the irradiation of enriched samples of the individual isotopes in the mixed radiative field of a nuclear reactor. Reactions for which cross sections were determined include: $Cd^{112}(n,2n)Cd^{111}$, $\bar{\sigma}$ = 0.35 mb; $Ba^{138}(n,2n)Ba^{137m}$, $\bar{\sigma}$ = 2.0 mb; and $Sr^{87}(n,n')Sr^{87m}$, $\bar{\sigma}$ = 0.12 b. All three isomers give rise to detection sensitivites in the low nanogram range for reactor neutron fluxes in excess of 10^{13} neutrons/cm^2/sec. (auth)

20989 (TID-18505) HEAVY ION ELASTIC SCATTERING. G. H. Rawitscher, J. S. McIntosh, and J. A. Polak (Yale Univ., New Haven). [1963]. Contract AT(30-1)-1807. 23p.

The elastic scattering of heavy ions at energies close to the Coulomb barrier is examined. Calculated differential cross sections for $N^{14}-C^{12}$, $N^{14}-N^{14}$, and $C^{12}-O^{16}$ are compared with experimental results. Incorporation of the nuclear-nucleus potential into a Schroedinger equation is particularly discussed, and several procedures are considered. Cross sections derived by the various methods did not display the wiggles noted in experimental results. Dependence of nuclear phase shifts on the angular momentum quantum number L is also examined. (D.C.W.)

20990 (TID-18506) THIRD ORDER REORIENTATION EFFECT IN HEAVY ION COULOMB EXCITATION. D. L. Lin and J. F. Masso (Yale Univ., New Haven). [1963]. Contract AT(30-1)-1807. 23p.

The reorientation effects that offer possibilities for the determination of the static quadrupole moment of nuclear excited states in Coulomb excitation experiments with heavy ions are examined. The inelastic scattering cross section for the reorientation effect, taking into account only transitions between magnetic substates of an excited state with I = 2 reached in an E2 excitation from a ground state with I = 0, is calculated by semiclassical techniques. The second order correction to the cross section for Ne^{20} inelastic scattering by Cd^{114} is derived. Results indicate that measurement of the reorientation effect should be most favorable when effects higher than second order are small. The static quadrupole moment is directly proportional to the second order reorientation parameter. (auth)

20991 (TID-18507) INDIRECT ASPECTS OF DIRECT INTERACTIONS. K. R. Greider (Yale Univ., New Haven). [1963]. Contract AT(30-1)-1807. 21p.

Validity of classical representation of direct interactions is questioned, and an approach that includes indirect interaction processes is proposed. Semiclassical and tunneling theories are also discussed. Angular distributions for O^{18} scattering on Pb^{208}, calculated by the indirect interaction process, agreed well with other experimental data. Transfer calculations for $Mg^{25}(N^{14},N^{13})Mg^{26}$ and $C^{12}(B^{10},Be^{9})N^{13}$ reactions show the effects of nuclear absorption. (D.C.W.)

20992 (TID-18508) APPROXIMATIONS OF NUCLEON TRANSFER THEORY. G. Breit (Yale Univ., New Haven). Apr. 1963. Contract AT(30-1)-1807. 19p.

The validity of assumptions used in deriving cross sections for reactions in which a nucleon is transferred from one nucleus to another in terms of reduced widths of nucleons in their bound states is examined. Transition from semiclassical to quantum mechanical description of the process is considered, and the cross section of the $N^{14}(N^{14},N^{13})N^{15}$ reaction is studied. (D.C.W.)

20993 (UCRL-7061) NORMALIZATION OF THE EPITHERMAL U^{235} FISSION CROSS SECTION. C. D. Bowman, G. F. Auchampaugh, and S. C. Fultz (California. Univ., Livermore. Lawrence Radiation Lab.). Feb. 14, 1963. Contract W-7405-eng-48. 13p.

Additional experiments were carried out to corroborate values for the fission cross section of U^{235} between 5 and 60 ev, as presented in UCRL-6926. The energy dependence of the neutron flux was restudied, the effects of neutron scattering were investigated, and the backgrounds were more thoroughly measured. The background corrections given in UCRL-6926 were found to be unnecessary. The results of these studies confirm the normalization reported in UCRL-6926. (auth)

20994 (UCRL-7233) NEUTRON SPECTRA FROM PROTON AND ALPHA BOMBARDMENT OF HEAVY NUCLEI. J. D. Anderson and C. Wong (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 21, 1963. Contract W-7405-eng-48. 22p.

Compound nuclear features in recent neutron spectra for (α,n) and (p,n) reactions are examined; the direct reaction features of (p,n) spectra are also discussed. Neutron spectra for particles of several energies are presented along with various angular distributions and nuclear temperature determinations. The statistical model of the compound nucleus is noted to describe most of a neutron spectrum, but direct processes also make contributions to (p,n) spectra. 22 references. (D.C.W.)

20995 (UCRL-7280) NUCLEAR CHARGE DISTRIBUTION IN SYMMETRIC FISSION — Sn^{121} INDEPENDENT YIELD. Arthur C. Wahl (Washington Univ., St. Louis) and David R. Nethaway (California. Univ., Livermore. Lawrence Radiation Lab.). Mar. 18, 1963. Contract W-7405-eng-48. 9p.

Experiments in which tin was separated from indium in a freshly irradiated solution of U^{235} gave evidence that In^{121} isomers are formed in thermal-neutron fission of U^{235}. Separation was effected by precipitation, and the fraction of 27.5-hr Sn^{121} growing from In^{121} after the separation was determined. Decay constants of the two In^{121} isomers and the fractions of 2.75-hr Sn^{121} from each isomer were determined. Half lives of the isomers and values for the fractions were obtained by a least squares analysis of the data on an IBM 7072 computer. The half lives of 3.3 ± 1.0 min and 29 ± 8 sec agree well with other determinations, and a yield curve calculated from the values derived agrees well with experimental results. These results support the hypothesis that many prompt neutrons are evaporated from fragments of nearly equal mass. (D.C.W.)

20996 (UCRL-9898) ENERGY AND ANGULAR DISTRIBUTIONS OF (α,α′) AND (d,α) REACTIONS (thesis). George Merkel (California. Univ., Berkeley. Lawrence Radiation Lab.). Nov. 1, 1961. Contract W-7405-eng-48. 119p.

Al, Cu, Ag, and Au targets were bombarded with 24-Mev deuterons and 48-Mev alpha particles. Some of the alpha-particle energy spectra and angular distributions produced in the resulting nuclear reactions were measured with a range-counter telescope. The data suggest that the compound-nucleus mechanism makes a significant contribution to the reaction cross sections in the case of the Al(α,α′)Al, Al(d,α)Mg, Cu(α,α′)Cu, and Cu(d,α)Ni reactions. The resulting compound-nucleus energy spectra and angular distributions are in fair agreement with predictions of the independent-particle theory, and with the semiclassical compound-nucleus theory of Ericson and Strutinski. 38 references. (auth)

20997 (UCRL-10609) HYPERFINE-STRUCTURE STUDIES OF Er^{169} AND ISOTOPES OF REFRACTORY ELEMENTS (thesis). Walter M. Doyle (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 23, 1963. Contract W-7405-eng-48. 83p.

The atomic-beam magnetic-resonance method was used to investigate the electronic and nuclear properties of Er^{169} and to determine the spins of several refractory-group nuclides. The apparatus used in the erbium research was sufficiently accurate to allow measurement of the nuclear dipole moment directly through its interaction with the external magnetic field. Investigations carried out in the $^3H_6$ electronic ground state yielded the results A = 725.46(31) Mc, $g_I \gtrsim 5.55(27) \times 10^{-4}$, and $g_J = -1.16381(5)$, where A is the dipole interaction constant, g_I and g_J are the nuclear and electronic g factors, respectively, expressed in terms of the Bohr magneton, and the nuclear spin $I = \frac{1}{2}$ had previously been determined. The value of the nuclear moment $\mu_I = +0.513(25)$ nm derived from g_I and corrected for diamagnetic shielding is consistent with the value inferred from the interaction constant if the $\langle 1/r^3 \rangle$ value of Lindgren is used and the possible effects of configuration mixing are neglected. Beams of refractory metals were produced by electron bombardment of narrow wire sources, and the spins of several nuclides were measured. These are listed along with the half lives and the electronic states in which resonances were observed. The experiments are discussed and the results interpreted in the light of current atomic and nuclear theory. 40 references. (auth)

20998 (UCRL-10649) STUDY OF THE NUCLEAR ZEEMAN EFFECT IN Au^{197} (thesis). Ronald W. Grant (California. Univ., Berkeley. Lawrence Radiation Lab.). Jan. 29, 1963. Contract W-7405-eng-48. 82p.

Mössbauer experiments were performed in external magnetic fields up to 86 kgauss with Pt^{197} dissolved in Fe, Co, and Ni sources, and Au absorbers. The magnetic moment of the 77-kev isomeric state of Au^{197} was measured as $\mu = +0.37 \pm 0.05$ nm. The hyperfine fields at Au nuclei dissolved in Fe, hex. Co, cubic Co, and Ni were found to be −1420 ± 220, −980 ± 150, −990 ± 150, and −340 ± 70 kgauss, respectively. The magnitude of the hyperfine field was found to be nearly proportional to the effective atomic magnetic moment of the host ferromagnetic material. Experiments were performed in an external magnetic field

with sources of Pt^{197} dissolved in Be and Pt in an attempt to measure μ directly; however, complicated behavior was observed which is explicable in terms of mixed magnetic dipole and electric quadrupole interactions. The effect of magnetostriction was observed in ferromagnetic sources which makes sign determinations of internal fields in ferromagnets, using the Mössbauer effect, less straightforward than is usually assumed. 48 references. (auth)

20999 ABSORPTION OF NEUTRINOS IN THE COULOMB FIELD OF THE NUCLEI. M. Elkishen (Roland Eötvös Univ., Budapest). Acta Phys. Acad. Sci. Hung., 15: 235-46(1963). (In English)

The cross sections of high energy neutrinos are calculated for the absorption in the Coulomb field of atomic nuclei, giving another neutrino and two charged leptons. The cases of the local Fermi interaction and the case of the indirect weak interaction (transmitted by a boson field with heavy quanta) are discussed separately. The probability of the emission of a real heavy boson is also determined. (auth)

21000 ON SOME POSSIBILITIES OF DETERMINING THE SPIN OF A "NEGATIVE LEVEL." J. Rondio and Z. Wilhelmi (Inst. of Nuclear Research, Polish Academy of Sci., Warsaw and Univ. of Warsaw). Acta Phys. Polon., 23: 221-3(Feb. 1963). (In English)

A method is suggested to establish negative resonance levels and to determine the probable spin value of these levels. The method is exclusively applicable in cases when the compound nucleus formed in result of neutron absorption looses its excitation through gamma transitions that can leave the final nucleus in a metastable or ground state. If the nucleus in each of these states is unstable, it is possible, by observing the decay of these states, to determine the ratio of their respective saturated activities and the relative abundance of both states. The method is applied to Rh^{103}. (C.E.S.)

21001 COMPOUND NUCLEUS INFLUENCE ON COULOMB EXCITATION. M. Micu (Inst. for Atomic Physics, Bucharest). Acta Physiol. Polon., 13: 305-20(Mar. 1963). (In English)

The influence of nuclear forces on the Coulomb excitation is studied by taking into account the compound-nucleus formation. The compound nucleus contributes not only by adding a nuclear term to the transition amplitude but also by distorting the initial and final wave functions of the relative motion. These distorted waves appear in the Born approximation for the transition amplitude given by the electromagnetic interactions. The calculated interference terms between the electromagnetic and nuclear interactions represent more than 10 per cent in the 780 kev resonance cross-section of the proton collision on F^{19}. (auth)

21002 KINEMATICAL PROPERTIES OF DEFORMED NUCLEI AND THE HILL-WHEELER INTEGRALS: I. THE FIRST APPROXIMATION OF THE g_R FACTOR. Han-Chou Liu (Nankai Univ., Tientsin, China). Acta Physiol. Polon., 13: 287-98(Mar. 1963). (In English)

The kinematical properties of deformed, intermediate, and heavy nuclei are studied by means of wave functions generated from the Hill-Wheeler integrals, using the Gaussian approximation. General formulas for the magnetic moment and the g_R factor are obtained. Using the Nilsson potential with pair-correlation interaction, numerical results to the first approximation are obtained for the g_R factor of nuclei with $152 \leq A \leq 185$. The calculated g_R values are on the average about 35% larger than the experimental values. For an essential further improvement the next approximation would have to be taken into account. (auth)

21003 ON THE ALPHA ACTIVITY OF NEUTRON DEFICIENT EUROPIUM AND GADOLINIUM ISOTOPES. Antti Siivola (Univ. of Helsinki). Ann. Acad. Sci. Fennicae, Ser. A, VI, No. 109, 1-34(1962). (In English)

New measurements have been made on the alpha decay of some rare earth nuclides. The following results are reported:

	E_α	$T_{\frac{1}{2}}$ or branching
Sm^{147}	(2.23 ± 0.01) Mev	
Eu^{147}	(2.91 ± 0.01) Mev	$(2.2 \pm 0.6) \times 10^{-5}$
Eu^{148}		$<10^{-6}$
Eu^{149}		$<4 \times 10^{-9}$
Gd^{148}	(3.18 ± 0.01) Mev	(84 ± 9) y
Gd^{150}	(2.73 ± 0.01) Mev	$(2.1 \pm 0.3) \times 10^6$ y

As a by-product, the half life of Dy^{152} was found to be (2.41 ± 0.05) hours and that of Eu^{150}, (12.55 ± 0.05) hours. A value of 5% was obtained for the electron capture branching in the decay of Eu^{150}. The experimental method of alpha spectroscopy is described. A brief discussion of the alpha decay of some rare earth nuclides is given. (auth)

21004 DEUTERON PHOTODISINTEGRATION IN THE MEDIUM ENERGY RANGE. R. M. K. Haemaelaeinen (Univ. of Helsinki, Finland). Ann. Acad. Sci. Fennicae, Ser. A VI, 125: 1-35(1962). (In English)

The photodisintegration of the deuteron in the medium-energy range is investigated by using an exact multipole expansion. Cross sections are calculated at gamma energies of 52.3, 77.3, and 122.4 Mev. The numerical results show that the long-wavelength approximation is satisfactory in this energy range. Changing the D-state probability from 5 to 3% and the hard core radius from 0.43 fm to 0 reduces the cross sections by an amount exceeding the experimental uncertainies. Explicit expressions for the cross sections are derived for E_1 and M_1 spin-flip transitions. (auth)

21005 RESONANCE ENERGIES FOR PROTON CAPTURE IN Ne^{21} AND Ne^{22}. S. E. Arnell and E. Wernbom (Chalmers Tekniska Hogskola, Goteburg). Arkiv Fysik, 23: 301-6(1963). (In English)

The gamma ray excitation functions for the $Ne^{22}(p,\gamma)Na^{23}$ and the $Ne^{21}(p,\gamma)Na^{22}$ reactions were studied in the energy range 600 to 1400 kev proton bombarding energy, using electromagnetically separated isotopes. In the $Ne^{22}(p,\gamma)Na^{23}$ reaction 22 resonances were found, 13 of which are new. In the $Ne^{21}(p,\gamma)Na^{22}$ reaction one new resonance was found and some previously reported resonances seemed to originate from contaminants. (auth)

21006 EXPERIMENTAL STUDIES OF THE ELECTROMAGNETIC TRANSITIONS FROM THE FIRST EXCITED STATES IN Hf^{177}, Lu^{175} AND Lu^{177}. J. Lindskog, T. Sundstroem, and P. Sparrman (Uppsala Univ.). Arkiv Fysik, 23: 341-54(1963). (In English)

The lifetimes of the first excited states of Hf^{177}, Lu^{175}, and Lu^{177} were measured by the delayed coincidence technique. In Lu^{177} the energies of the transitions from first and second excited states to the ground state were remeasured and the $L_I + L_{II}/L_{III}$ ratio for the 122 kev transition was determined. The properties of the three transitions treated are discussed in terms of the unified model. The possibility that the conversion coefficient for the 113 kev transition in Hf^{177} is affected by nuclear structure effects is considered. (auth)

21007 ON THE DECAY OF Pb^{200}. B. Wirhed and C. J. Herrlander (Nobel Inst. of Physics, Stockholm). Arkiv Fysik, 23: 355-66(1963). (In English)

The conversion lines following the decay of Pb^{200} were studied in a double-focusing beta spectrometer and a semi-

circular permanent magnet beta spectrometer covering the energy range 15–700 kev. Conversion lines corresponding to 15 transitions in Tl^{200} were found. Electron–electron coincidence measurements were performed in a double intermediate image spectrometer. Transitions indicating three new levels were observed and a level scheme is given, including the following excited levels: 147.61, 257.15, 289.11, 289.94, 450.5, 525.6, and 605.3 kev. (auth)

21008 GAMMA RAYS FROM THE CAPTURE OF FAST NEUTRONS IN U^{238}. I. Bergqvist (Research Inst. of National Defence, Stockholm and Univ. of Lund, Sweden). Arkiv Fysik, 23: 417-23(1963). (In English)

The γ-ray spectra resulting from the capture of neutrons with energies 10, 40, 125, and 300 kev were studied using a 5" NaI(Tl) crystal as the spectrometer in combination with the time-of-flight technique. No difference between the spectra of the four cases is observed. Remarkably good agreement with the spectrum calculated from the statistical model is obtained, whereas there may be a difference between the spectra at fast neutron energies and the spectrum at thermal energy. (auth)

21009 FAST NEUTRON RADIATIVE CAPTURE CROSS SECTIONS IN Ag, Ta, W, Au, Hg, and U. I. Bergqvist (Research Inst. of National Defence, Stockholm and Univ. of Lund, Sweden). Arkiv Fysik, 23: 425-34(1963). (In English)

Radiative capture cross sections at neutron energies between 18 and 300 kev were measured for the elements Ag, Ta, W, Au, Hg, and U, using time-of-flight technique and a 5 inch NaI scintillation spectrometer. Silver was used as a standard and the capture cross sections for the other elements were determined relative to those of the standard. By means of a long counter the relative neutron yield from the $Li^7(p,n)Be^7$ reaction as a function of proton energy was measured at the angles of 95° and 120° to the proton beam. It is thereby possible to study the neutron energy dependence of the capture cross section. The results are in fair agreement, except in the case of uranium, with previous measurements based on the detection of the γ-rays resulting from the neutron capture. 22 references. (auth)

21010 GAMMA-RAY SPECTRA FROM THE CAPTURE OF FAST NEUTRONS IN Ni AND Cu. I. Bergqvist and N. Starfelt (Research Inst. of National Defence, Stockholm and Univ. of Lund, Sweden). Arkiv Fysik, 23: 435-45(1963). (In English)

The γ rays produced in the capture of thermal and fast neutrons in nickel and copper were studied by means of a NaI scintillation spectrometer. The results show that for both elements the relative intensity of high-energy γ rays is lower for fast neutrons than for thermal. It was also found that the shape of the γ-ray spectrum from nickel varies with neutron energy in the range 15 to 300 kev. For copper no such neutron energy dependence was observed. 29 references. (auth)

21011 DETERMINATION OF THE MEAN LIFETIME OF N^{16} IN THE FIRST NUCLEAR REACTOR OPERATING IN PERU. Ignacio Frisancho Pineda. Bol. Inform. Junta Control Energ. At. (Peru), 7: 5p.(1962). (In Spanish)

The method used for the determination of the mean lifetime of N^{16} produced in the nuclear reaction $O^{16}(n,p)N^{16}$ is described. A value of 7.22 sec was obtained, in good agreement with previous measurements. (J.S.R.)

21012 GAMMA-GAMMA DIRECTIONAL CORRELATIONS OF SOME GAMMA RAY CASCADES IN ^{110}Cd. Takeshi Mukoyama, Fumiyoshi Makino, and Sakae Shimizu (Shimizu Lab., [Japan]). Bull. Inst. Chem. Res., Kyoto Univ., 40: 307-16(Nov. 1962). (In English)

Directional correlation experiments were performed for the 1386 kev–884 kev, 760 kev–1509 kev, 934 kev–884 kev, gamma cascades in Cd^{110}. The gamma rays were arranged in a plausible decay scheme. By the present measurements the spin sequences and multipolarity assignments 5(D,Q) 4(Q)2, 5(D,Q)4(Q)2, 6(Q)4(Q)2, and 4(Q)2(Q)0 were ascribed to these four gamma cascades, respectively. (auth)

21013 THE ALPHA DECAY OF EVEN-EVEN NUCLEI. N. R. Steenberg and R. C. Sharma (Univ. of Toronto). Can. J. Phys., 41: 664-78(Apr. 1963).

The distribution of alpha particles on the surface of even-even alpha-emitting nuclei was calculated by an approximate method initiated by V. G. Nosov and resembling Frőman's. Good agreement was obtained with the result of inward integration. (auth)

21014 NEUTRON SEPARATION ENERGIES FOR ZIRCONIUM AND THE $Zr^{96}-Nb^{96}$ AND $Nb^{94}-Zr^{94}$ DECAY ENERGIES. R. C. Barber, R. L. Bishop, W. McLatchie, P. Van Rookhuyzen, and H. E. Duckworth (McMaster Univ., Hamilton, Ont.). Can. J. Phys., 41: 696-701(Apr. 1963).

Values are reported for the $Zr^{92}-Zr^{90}$, $Zr^{94}-Zr^{92}$, and $Zr^{96}-Zr^{94}$ mass differences. These are combined with existing data to compute neutron separation energies for Zr^{94} and Zr^{96} and the energies available for the $Zr^{96}-Nb^{96}$ and $Nb^{94}-Zr^{94}$ decays. It is pointed out that marked regularities exist amongst the neutron separation energies for zirconium and tin. (auth)

21015 MICROCALORIMETRIC DETERMINATION OF THE CHARACTERISTICS OF YTTRIUM-90 AND THE ENERGY LOSS DUE TO β BREMSSTRAHLUNG. Pierre Boivinet, Edouard Calvet, and Yves Ozias (Institut de Microcalorimétrie et de Thermogenèse, Marseille). Compt. Rend., 256: 1103-5(Jan. 28, 1963). (In French)

The characteristics of Y^{90} were studied microcalorimetrically and the loss from bremsstrahlung was measured. A theoretical calculation of the energy loss for S^{35}, I^{131}, P^{32}, and Y^{90} was in agreement with the experimental results. It was shown that the loss in the case of P^{32} and especially Y^{90} was appreciable. These results are given in tabular form. (J.S.R.)

21016 CONTRIBUTION TO THE STUDY OF THE TERNARY FISSION OF URANIUM-235 INDUCED BY SLOW NEUTRONS. André Michaudon, André Lottin, and Daniel Paya. Compt. Rend., 256: 1490-3(Feb. 11, 1963). (In French)

Several resonances of U^{235} were studied between 3 and 21 ev by a neutron time-of-flight method. It is shown that the probability of ternary fission and also the spectrum of long-path α rays vary from resonance to resonance. (tr-auth)

21017 ANGULAR DISTRIBUTIONS OF He^3 FROM THE $Li^6(p,\alpha)He^3$ REACTION FROM 130 TO 530 Kev (EXPERIMENTAL RESULTS). Henri Beaumevieille, Nicole Longequeue, and Jean-Pierre Longequeue (CEN, Grenoble, France and Université, Grenoble, France). Compt. Rend., 256: 1494-6(Feb. 11, 1963). (In French)

The variation of the b_2 coefficient of the Legendre polynomials for the angular distribution of the $Li^6(p,\alpha)He^3$ reaction was studied from 130 to 530 kev and is incompatible with the present hypotheses on excited states of Be^7. (tr-auth)

21018 A PROPOSAL FOR NUCLEAR SPIN COOLING. C. D. Jeffries (Univ. of California, Berkeley). Cryogenics, 3: 41(Mar. 1963).

A method of orienting nuclear spins is suggested that is a combination of adiabatic rotational cooling of paramagnetic ions, rapid spin temperature mixing between neigh-

boring spins with equally spaced energy levels, and appreciable anisotropy of the spin-lattice relaxation time for certain paramagnetic ions. (C.E.S.)

21019 SOME NEW SCHEMES FOR DYNAMIC NUCLEAR POLARIZATION. A. Abragam (Collège de France, Paris). Cryogenics, 3: 42-3(Mar. 1963).

The conditions under which nuclear spins can be cooled to temperatures of the order of a few millidegrees in relatively large fields are analysed using as a coolant a small portion of paramagnetic electron spins imbedded in the lattice of diamagnetic crystals. (C.E.S.)

21020 CORRECTION FOR ENERGY OF LARGE NUCLEI IN BRUECKNER'S THEORY. A. Kujanová-Zentková. Czech. J. Phys., 13: 1-7(1963). (In English)

The calculation of corrections for energy of large nuclei giving the difference between the true energy of the atomic nucleus and its model according to Brueckner's theory is presented. It is seen that the principal contribution is –0.48 Mev to the nucleon and that the other contributions are negligibly small. (auth)

21021 RADIOACTIVE DECAY OF Os^{191} AND Os^{191m}. Z. Plajner, L. Malý, N. Eissa, and A. Benedek (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 13: 23-30(1963). (In English)

Beta and gamma spectra of Os^{191} were studied using a magnetic double-focusing beta spectrometer and a scintillation spectrometer. The isomeric state Os^{191m} decays through the 74.4 ± 0.1 kev (E3/M4 = 50) transition with a half-life $T_{½}$ = 13.0 ± 0.5 hours. A continuous beta spectrum with E_{max} = 147 ± 3 kev and the gamma transitions 41.83 ± 0.05 kev (E3), 82.5 ± 0.3 kev, and 129.4 ± 0.1 kev (70% M1 + 30% E2) were observed in the decay of the ground state of Os^{191}. The conversion coefficient of the last transition was determined as 1.94 ± 0.10. Gamma transitions with energies of 47 kev and 185.8 kev were not observed. (auth)

21022 MATRIX ELEMENTS IN THE β-DECAY OF Ir^{192}. M. Šott (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 13: 75-6(1963). (In Russian)

Six matrix elements: $\int\sigma\cdot r$, $\int\gamma_5$, $\int r$, $\int\alpha$, $\int\sigma\times r$, and β_{ij} (when $I \geq 1$) are observed in $\Delta I = 0$, first forbidden β transitions. An analysis was made of such transitions in Ir^{192} decay. Nuclear polarization of Ir^{192} was reached in iridium-iron alloy at 0.03 to 0.1°K. The polarization was determined using the γ anisotropy of pure E2 transition at 468 kev. The transition $4^- \rightarrow 3^+$ was completely determined by matrix elements $\int r$, $\int\alpha$, and $\int\sigma\times r$. The theoretical approximation for the transition asymmetry coincides with the allowed transition $I \rightarrow I-1$: $a_1 = (v/c)\cdot f_1$. The transition $4^- \rightarrow 4^+$ is specified by mixed λ and μ processes corresponding to the Fermi, Gamow-Teller processes in allowed $\Delta I = 0$ transitions. (R.V.J.)

21023 DECAY OF Sm^{155}. B. Kracík, Z. Miligui, V. Brabec, M. Vejs, A. Maštalka, and T. Kucarová (Inst. of Nuclear Physics, Czechoslovak Academy of Sciences, Řež). Czech. J. Phys., 13: 79-83(1963). (In English)

The continuous beta and the conversion electrons spectra of Sm^{155} was studied with an intermediate image magnetic lens spectrometer and a scintillation spectrometer with a NaI(Tl) crystal connected to a 200-channel amplitude analyzer. By means of a Fermi plot the end point energy of the most intensive component of the continuous beta spectrum was found to be 105 kev. (C.E.S.)

21024 CROSS-SECTION FOR THE FORMATION OF Li^8 IN A NUCLEAR EMULSION BY 9-Bev PROTONS. N. P. Bogachev, E. L. Grigor'ev, and Yu. P. Merekov. Dokl. Akad. Nauk SSSR, 148: 1046(Feb. 11, 1963). (In Russian)

The formation cross section of Li^8 by protons of 9-Bev energy was calculated to be 2.4 ± 0.6 mb. This agrees with values of approximately 2 mb found in other work with 1-Bev particles. The calculation was made from statistical data obtained by microscopic examination of tracks in irradiated NIKFI-R emulsion. Of 19,411 nuclear disintegrations observed, 133 (after necessary corrections were made) were characteristic of Li^8. (TTT)

21025 NEW NEUTRON-DEFICIENT ISOTOPES OF THE CERIUM-GROUP RARE-EARTHS ELEMENTS. A. K. Lavrukhina and G. M. Kolesov. Dokl. Akad. Nauk SSSR, 148: 1047-8(Feb. 11, 1963). (In Russian)

In a further search for new light isotopes of the cerium rare earth group elements, a series of isobars was apparently separated: $Ce^{129} \xrightarrow{\sim 13\ min} La^{129} \xrightarrow{\sim 20\ min} Ba^{129} \xrightarrow{2.2\ hr} \ldots \rightarrow Xe^{129}$ stable. The work was done by cyclotron irradiation of a 99.96% Pr_6O_{11} target with 660-Mev protons. Rare earth fractions were separated chromatographically, and cerium was extracted from 8 to 10 N HNO_3 by diethyl ether, requiring 3–4 hr. The curve for Ce^{134} decay shows a half life of 40 ± 7 min for Pr^{134}, the latter decaying probably with a gamma energy of about 720 kev. Lanthanum isotope decay curves show $La^{132,133}$ with a half life of 4.3 hr, La^{131} with 1.1 hr, and a new isotope, apparently La^{129}, with about 20 min. The Ce fraction showed a half life of about 13 min and a gamma radiation of 80 ± 15 kev, apparently from Ce^{129}. The La fraction showed gamma radiations of 115 ± 20 kev and 175 ± 15 kev with a half life of 2.2 hr, apparently Ba^{129}. In the Ce fraction also were gamma radiations of 315 ± 20 and 745 ± 20 kev. (TTT)

21026 DETERMINATION OF THE ISOBARIC STATES IN MODELS WITH A FIXED NUCLEON. A. R. Frenkin (Moscow State Univ.). Dokl. Akad. Nauk SSSR, 148: 1060-3(Feb. 11, 1963). (In Russian)

In studying interacting excited systems, certain simplifying assumptions must be made because of their complex character. For this reason, in the study of the isobaric states of systems containing fixed nucleons which interact strongly with charged mesons, the effect of the uncharged mesons was neglected. The charge degeneration of the system was determined as a function of the charge energy without the necessity of making the transformations used by S. Serber and S. Dancoff (Phys. Rev. 63: 143(1943)). A correlation was derived on the basis of the Heisenberg equation of motion between the boson and fermion operators, determining the isotopic moment of inertia and defining the isobaric energy as the energy of revolution of the system in the isotopic space around an axis with a given angular velocity and moment of inertia. The method may be applied for solving more complex problems. (TTT)

21027 INELASTIC SCATTERING OF 14.7-Mev NEUTRONS ON U^{238}. C. Poppelbaum, P. Huber, Z. Lewandowski, R. Plattner, and R. Wagner (Universität, Basel). Helv. Phys. Acta, 35: 733-55(1962). (In German)

The spectrum resulting from 14.7 Mev neutrons incident on U^{238} was measured with a time-of-flight spectrometer. The evaporation part of the spectrum is obtained by subtracting the spectrum of fission neutrons. Analysis of this "difference spectrum" in terms of the Le Couteur distribution yields the nuclear temperature. A first determination of the nuclear temperature was made by supposing the fission neutrons to have a Watt distribution. The result allows one to calculate the mean excitation energies of the nuclei involved in the emission of the neutron cascade. A new distribution of fission neu-

trons is derived, based on Terrel's assumption that a distribution of the form $f(E)dE = E^{\frac{1}{2}} e^{-E/\Theta}\, dE$ describes the spectrum of fission neutrons in the laboratory system. The parameter Θ is related to the above mentioned excitation energies by the number of neutrons per fission. It is shown, that both these distributions lead to essentially the same nuclear temperature T = 0.36 ± 0.02 Mev for U^{238} at a mean excitation energy of 14 Mev. The relation between nuclear temperature and the level density allows the calculation of the level density coefficient a. The value a = 96 Mev^{-1} obtained is substantially higher than expected by the theory of Newton, but the results of other authors for U^{238} suggest a deviation of the level density coefficient toward higher values as well. (auth)

21028 THE NUMBER OF NEUTRONS EMITTED BY THE INDIVIDUAL FRAGMENTS FROM ^{235}U FISSION. V. F. Apalin, Yu. P. Dobrynin, V. P. Zakharova, I. E. Kutikov, and L. A. Mikaelyan. J. Nucl. Energy, Pt. A & B, 17: 25-30(Jan. 1963). (In English)

The number of neutrons emitted by the individual fragments produced in the thermal neutron fission of U^{235} was measured using a large cadmium-loaded organic liquid scintillator as a detector. The number of neutrons emitted by the pair of fragments was measured as a function of their mass ratio under conditions of 4π geometry. The semi-empirical mass formula of Weizsäcker was used to determine the amount of excitation energy removed by the evaporated neutrons. It was found that the division of excitation energy between the light and heavy fragments was strongly asymmetric. The results obtained are at variance with the statistical theory of fission given by Fong. (auth)

21029 MEASUREMENT OF THE BRANCHING RATIO BETWEEN PROTONS AND ALPHA PARTICLES FOR THE 20-Mev LEVEL IN Be^8. A. Garin and L. Marquez (Centre d'Etudes Nucléaires, Saclay, France). J. Phys. Radium, 23: 970-2(Dec. 1962). (In French)

The branching ratio between protons and alpha particles was measured for the 20 Mev level in Be^8. This level is produced in the reaction $Li^6 + Li^6 = \alpha + Be^{8*}$. The measurements were made by the observation of the tracks of protons and alpha particles in nuclear plates. It was found that $\Gamma_p : \Gamma_\alpha = 1.64$. (auth)

21030 CROSS SECTIONS OF (γ,p) REACTIONS PRODUCED BY γ RAYS OF 14.8 AND 17.6 Mev ON Al, Ni, Cu, AND Ag. W. Sebaoun (Laboratoire Joliot-Curie de Physique Nucléaires, Orsay, France). J. Phys. Radium, 23: 989-92(Dec. 1962). (In French)

The cross sections of (γ,p) reactions induced on Al, Ni, Cu, and Ag by the γ radiation from the $Li^7(p,\gamma)$ reaction were measured relatively to the known cross section σ_0 of the $Cu^{63}(\gamma,n)$ reaction. Assuming for σ_0 the value (82 ± 8) mb, the obtained cross sections are: σ(Al) = (7.2 ± 1.1) mb, σ(Ni) = (43 ± 5) mb, σ(Cu) = (9.8 ± 1.4) mb, σ(Ag) = (6.2 ± 0.9) mb. These results were used to compare the ratios σ_p/σ_n of the cross sections for the (γ,p) and (γ,n) reactions on Ni, Cu, and Ag, with the data from the statistical theory. (auth)

21031 ANGULAR DISTRIBUTION OF PHOTO-PROTONS FROM Al AND Cu. Masatoshi Odera and Nobuhiro Yamamuro (Tokyo Inst. of Tech.). J. Phys. Soc. Japan, 18: 325-8(Mar. 1963). (In English)

The angular distributions of photoprotons from Al and Cu irradiated with 22 Mev bremsstrahlung are measured. The result of Al shows a marked forward peak for total protons of energies above 2 Mev as well as for those above 6 Mev. The latter can be fitted with $1 + 0.64 \sin^2\theta\ (1 + 1.5 \cos\theta)^2$. Protons above 7 Mev from Cu have a symmetrical distribution around 90° that can be represented as $1 + 1.3 \sin^2\theta$, whereas total protons above 2 Mev have isotropic distribution. (auth)

21032 DECAY OF In^{108}. Toshio Katoh (Nagoya Univ., Japan), Hiroshi Gotoh, and Yasukazu Yoshizawa. J. Phys. Soc. Japan, 18: 461-2(Mar. 1963). (In English)

The decay of In^{108} is investigated by means of Ag^{107} foils irradiated with 38-Mev alpha particles. The half life and decay scheme were determined. (C.E.S.)

21033 TABLE OF DATA CHARACTERIZING NEUTRON-INDUCED REACTIONS. P. Bornemisza, Comp. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: No. 3-4 Suppl., 12p. (Dec. 1962). In English and Hungarian)

The possible reactions and their characterizing data for each stable isotope are surveyed. The table is especially useful in planning neutron-induced experiments using the activation method and in the evaluation of the activity produced. The table includes the reactions (n,p), (n,α), (n,2n), (n,γ), (n,d), (n,np), (n,t), (n,He^3), and (n,n'α). It contains all the stable isotopes of each element and the radioactive ones of long half life ($T_{\frac{1}{2}} > 10^6$ years), the residual nuclei produced in the reactions mentioned above, their half life, and the reaction threshold energy. Threshold energy values were calculated. The Q-values were taken from the table of Howerton for the reactions (n,np) and (n,nα), and from the table of Ashby and Catron for the other reactions. (auth)

21034 MEASUREMENT OF $\sigma_{n\alpha}/\sigma_{np}$ CROSS SECTION RATIO ON Na^{23} AND Al^{27} NUCLEI AT 14.6 Mev NEUTRON ENERGY. Gyula Csikai, Borbála Gyarmati, and Ilona Hunyadi. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 137-42(Dec. 1962). (In Hungarian)

The following cross section ratios were found for Al^{27} and Na^{23} nuclei by the activation method for reactions produced by 14.6-Mev neutrons: $\sigma_{n\alpha}/\sigma_{np} = 1.64 \pm 5\%$; $\sigma_{np}/\sigma_{n\gamma} = 128.3 \pm 12\%$; and $\sigma_{n\alpha}/\sigma_{np} = 3.88 \pm 7\%$. A comparison of cross section ratios calculated from statistical theory with various level-density formulas indicates that, for the ratios of direct and compound protons, the best coincidence can be obtained by aid of a level-density formula utilizing rounded potential. (auth)

21035 THE (n,p), (n,d) AND (n,α) REACTIONS INDUCED BY 14.6 Mev NEUTRONS IN CsI(Tl) SCINTILLATION CRYSTALS. W. R. Dixon (National Research Council, Ottawa). Nucl. Phys., 42: 27-45(Apr. 1963). (In English)

The (n,p), (n,d), and (n,α) reactions induced by 14.6 Mev neutrons in CsI(Tl) scintillation crystals were observed. Pulse shape discrimination was used to distinguish the various particles, permitting an energy spectrum for each to be obtained. The proton and alpha particle spectra were analyzed from the point of view of the statistical theory of nuclear reactions, but there are left over substantial components that must be attributed to direct interactions. The direct component for protons is estimated to be at least 45%, and for alpha particles to be at least 38%. Absolute cross sections have been obtained by the method of tagging the neutron beam by its associated particles; the averages for Cs and I are found to be σ(n,p) = 8 ± 1 mb, σ(n,d) = 1.2 ± 0.2 mb, and σ(n,α) = 1.8 ± 0.2 mb. (auth)

21036 PROJECTION THEOREM FOR ENERGY LEVELS. Syurei Iwao (Università, Genoa and Istituto di Fisica Nucleare, Genoa). Nucl. Phys., 42: 46-55(Apr. 1963). (In English)

The spectroscopy of simple nuclear systems is developed assuming two-body N-N forces and the j-j coupling scheme.

The level schemes arising from the ground configurations of Ar^{38} and Ar^{40} are discussed. The method, however, in principle applies to the spectroscopy of nuclei with excited configurations. The physical significance of applications and possible future problems are discussed. (auth)

21037 DETERMINATION OF K CONVERSION COEFFICIENT OF 279 kev TRANSITION IN Tl^{203}. R. Burmeister, H. Graber, J. Schintlmeister, and R. Weibrecht (Technische Universität, Dresden). Nucl. Phys., 42: 56-61 (Apr. 1963). (In German)

The K conversion coefficient of the 279 kev transition in Tl^{203} was measured using a NaI(Tl) scintillation spectrometer. The measurements, carried out under different experimental conditions, yield a mean value of $\alpha_K = 0.168 \pm 0.008$ in sufficient agreement with values, obtained with other methods. (auth)

21038 STUDY OF SOME EXCITED LEVELS OF Be^9 BY INELASTIC ELECTRON SCATTERING. H. Nguyen Ngoc, M. Hors, and J. Perez y Jorba (Ecole Normale Supérieure, Laboratoire de l'Accélérateur Linéaire, Orsay, France). Nucl. Phys., 42: 62-74(Apr. 1963). (In English)

Inelastic scattering of high energy electrons from Be^9 was observed. Three levels at 1.6, 2.47, and 6.4 Mev above the ground state are excited by E1, E2, and E2 transitions, respectively. The radiative widths of the inverse transition were found to be (4.5 ± 0.6); $(2.6 \pm 0.1)\ 10^{-3}$, and (0.109 ± 0.005) ev. No other levels were observed up to 17 Mev excitation energy. The 2.47 and 6.4 Mev levels seem to be members of a rotational band $K = 3/2^-$ based on the ground state. (auth)

21039 THE NON-LOCALITY OF THE OPTICAL POTENTIAL. G. Ripka (Laboratoire de Physique Theorique et Hautes Energies, Orsay, France). Nucl. Phys., 42: 75-85(Apr. 1963). (In English)

In order to estimate its range of non-locality, the real and imaginary parts of the optical potential are evaluated to the second order in infinite nuclear matter. The imaginary part is found to pass through a maximum as the density decreases from its value at the center of a heavy nucleus, the range of non-locality remaining constant at approximately 1 fm. (auth)

21040 ELASTIC SCATTERING OF 1 Mev NEUTRONS. W. B. Gilboy and J. H. Towle (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). Nucl. Phys., 42: 86-94(Apr. 1963). (In English)

Differential elastic scattering cross-sections for 1 Mev neutrons were measured for twenty elements using the time-of-flight technique. Ten rare earth elements were included to fill a large gap in previous data in an interesting region of mass number. The measurements were individually corrected for flux attenuation and multiple scattering by a Monte Carlo method. The results are compared with the predictions of the Bjorklund-Fernbach optical method. (auth)

21041 VARIATIONAL CALCULATIONS ON THE BINDING ENERGY OF THE ALPHA PARTICLE. I. HARD-CORE POTENTIALS. E. W. Schmid, Y. C. Tang, and R. C. Herndon (Florida State Univ., Tallahassee). Nucl. Phys., 42: 95-112(Apr. 1963). (In English)

The upper and lower bound for the energy of the alpha particle are calculated. The two-body interaction used is a central, static potential with hard core that describes the low-energy scattering data and yields the experimental p-p $^1S_0$ phase shifts up to around 300 Mev. Numerical integrations are carried out by a Monte-Carlo method. The effect of using different forms of variational wave functions is investigated. The results obtained are -29.3 Mev for the upper bound and -83.8 Mev for the lower bound. (auth)

21042 VARIATIONAL CALCULATIONS ON THE BINDING ENERGY OF THE ALPHA PARTICLE. II. VELOCITY-DEPENDENT POTENTIALS. R. C. Herndon, E. W. Schmid, and Y. C. Yang (Florida State Univ., Tallahassee). Nucl. Phys., 42: 113-21(Apr. 1963). (In English)

The upper bound and the lower bound for the energy of the alpha particle are calculated with a central, velocity-dependent, two-body potential that fits the low energy scattering data and yields the experimental p-p $^1S_0$ phase shifts up to about 300 Mev. The results of -29.2 Mev and -63.6 Mev for these two bounds check quite closely with the corresponding results obtained with a hard-core potential. This indicates that in a nucleus in which the average inter-nucleon distance is somewhat longer than the range of the two-body potential, the binding energy is insensitive to the detailed nature of the potential. (auth)

21043 THE RADIUS AND COULOMB ENERGY OF THE He^3 NUCLEUS. J. N. Pappademos (Univ. of Chicago). Nucl. Phys., 42: 122-8(Apr. 1963). (EFINS-62-60). (In English)

The radius and Coulomb energy of He^3 are calculated using a symmetrical wave function appropriate to hard-core nuclear potentials and sufficiently flexible to describe adequately the asymptotic form and two-particle correlations in this system, requirements that are sufficient to fix the parameters of the wave function. For hard-core radius $d \approx 0.5$-0.6 fm, the rms radius agrees with that measured by Hofstadter and Collard, and the Coulomb energy is within 0.05 Mev of the difference between the (H^3,He^3) binding energies. From this comparison, it is concluded that deviations from charge symmetry amount to no more than of relative order α/π for the low energy n-n and p-p interactions in the $^1S_0$ state. (auth)

21044 ON THE RENORMALIZATION OF THE BETA-DECAY AXIAL CONSTANT. Nguyen Van-Hieu (Joint Inst. for Nuclear Research, Dubna, USSR). Nucl. Phys., 42: 129-33(Apr. 1963). (In English)

The renormalization of the β-decay axial constant is considered in the Chew-Low theory with fixed nucleon. The renormalization constant $\lambda = -G_A/G_V$ is expressed in terms of the renormalized constant of meson(π)-nucleon strong interaction and total cross sections of meson(π)-nucleon scattering. (auth)

21045 ON l-FORBIDDEN M1 TRANSITIONS. M. K. Ramaswamy (Karnatak Univ., Dharwar, India). Nuovo Cimento (10), 27: 1116-18(Mar. 1, 1963). (In English)

An analysis of l-forbidden M1 transitions is carried out. Seven transitions for which the lifetime, conversion coefficient and E2/M1 mixing ratio are experimentally known are considered. The M1 transition probabilities show retardations (compared to single-particle estimates) ranging from 37 to 920, whereas the reduced E2 transition probabilities show enhancements ranging from 6 to 17. While configuration mixing can qualitatively explain the M1 matrix elements, the E2 enhancements clearly imply a collective type of behavior. However, the surface tension parameters calculated on the basis of the weak coupling model appear to be unreasonably large in some cases considered. (auth)

21046 STUDY OF HYPERFRAGMENTS PRODUCED IN 800 Mev/c K^- INTERACTIONS. I. MESONIC DECAYS. A. Z. M. Ismail, I. R. Kenyon, A. W. Key, S. Lokanathan,

and Y. Prakash (Oxford Univ.). Nuovo Cimento (10), 27: 1228-39(Mar. 1, 1963). (In English)

Mesic decays (92) of the hypernuclei obtained from 25,600 K^- stars at 800 Mev/c are analyzed. Fifty-two events are uniquely identified, including one π^+ decay of $_\Lambda He^4$ and 21 out of 36 ambiguous events are given a most probable interpretation; 4 decays in flight are observed. The ratios of π^- recoil decays to all π^- decay modes for $_\Lambda H^3$ and $_\Lambda H^4$ seem to agree with spin assignments of $\frac{1}{2}$ and 0, respectively. The production mechanism of the hypernuclei from the heavier nuclei of the emulsion is also discussed. (auth)

21047 THE SPIN-ORBIT INTERACTION IN SPHERICAL NUCLEI. P. E. Nemirovskii and V. Chepurnov (Kurchatov Inst. of Atomic Energy, Moscow). Phys. Letters, 4: 103-4 (Mar. 15, 1963). (In English)

Spin-orbit splitting was investigated for a number of spherical nuclei (O^{17}, Ca^{41}, Zr^{91}, Ba^{137}, Ce^{141}, Pb^{207}). The dependence of the energy of single-particle levels on the mass number is considered. The agreement of theoretical values with experimental ones is satisfactory. (C.E.S.)

21048 A TEST OF THE STATISTICAL NATURE OF FLUCTUATIONS IN NUCLEAR CROSS SECTIONS. L. L. Lee, Jr. and J. P. Schiffer (Argonne National Lab., Ill.). Phys. Letters, 4: 104-5(Mar. 15, 1963). (TID-18363; UAC 7240). (In English)

A study of the elastic scattering of protons from Ni and Cu isotopes is used as a test for the statistical nature of fluctuations in nuclear cross sections. Excitation functions for the 90° scattering from Ni indicate that the cross sections fluctuate with periods that are 2 or 3 times the experimental resolution widths. (C.E.S.)

21049 STUDY OF THE FIRST EXCITED LEVELS OF Ca^{40}. D. Blum (Ecole Normale Supérieure, Laboratoire de l'Accélérateur Linéaire, Orsay, France), P. Barreau, and J. Bellicard. Phys. Letters, 4: 109-12(Mar. 15, 1963). (In English)

The Ca^{40} isotope was studied by inelastic electron scattering to determine the higher electric multipole transition of this nucleus. Several series of measurements were carried out with 120-, 150-, 180-, and 220-Mev electrons. (C.E.S.)

21050 SPURIOUS Q-VALUES IN C^{12}-BREAKUP. N. K. Sherman (Queen's Univ., Kingston, Ont.). Phys. Letters, 4: 113-14(Mar. 15, 1963). (In English)

It is shown that the excited state of Be^8 is spurious in the distribution of prong-pair Q values, being due to resonant absorption of photons into the 15.11-Mev state of C^{12}. The energies of other photon absorption resonances are obtained from similar peaks via a linear relation between the spurious Q values and the photon energies. The distribution of possible Be^8 Q values are presented. (C.E.S.)

21051 A DYNAMICAL THEORY OF INTERNAL PARAMETERS FOR NUCLEAR COLLECTIVE MOTION. Ken-ji Hara (Tokyo Univ.). Phys. Letters, 4: 125-6 (Mar. 15, 1963). (In English)

A unified view of the semi-phenomenological theory of nuclear collective motion is presented along the ideas of a dynamical Hartree field, and expressions for the mass parameter and the force constant are derived without an adiabatic assumption. (C.E.S.)

21052 PHOTOFISSION OF Mg^{24}. N. K. Sherman (Queen's Univ., Kingston, Ont.). Phys. Letters, 4: 138-40 (Mar. 15, 1963). (In English)

Binary photofission of Mg^{24} is reported as evidence that one of the quasimolecular resonances in $C^{12}-C^{12}$ scattering is a state of Mg^{24}. The reaction $Mg^{24}(\gamma,C^{12})C^{12}$ is due to an E2 photon of 23.1 Mev. (C.E.S.)

21053 THE $B^{10}(p,He^3)Be^8$ REACTION. J. G. Jenkin, L. G. Earwaker, and E. W. Titterton (Australian National Univ., Canberra). Phys. Letters, 4: 142-3(Mar. 15, 1963). (In English)

Measurements of the excitation functions for the $B^{10}(p,He^3)$ reaction leading to the ground state of Be^8 taken at laboratory angles of 50 and 90° are reported together with a number of angular distributions obtained in the energy range 4 to 10 Mev. Similar information is reported for the $B^{10}(p,\alpha)Be^7$ reaction. (C.E.S.)

21054 THE ENERGY OF THE FIRST EXCITED STATE OF Be^9. E. G. Corman, J. E. Sherwood, and W. John (Univ. of California, Livermore). Phys. Letters, 4: 146-7 (Mar. 15, 1963). (UCRL-7234). (In English)

It is shown that the single-particle direct-interaction model that fits the $Be^9(\gamma,n)$ data implies that the first excited state is centered very near the threshold (1.667 Mev) for decay into Be^8 + neutron. Recent evidence from photodisintegration also points to this fact. (C.E.S.)

21055 THE NUCLEAR STRIPPING PROCESS UNDER CONDITIONS OF STRONG ABSORPTION. L. J. B. Goldfarb and M. B. Hooper (Univ. of Manchester, Eng.). Phys. Letters, 4: 148-50(Mar. 15, 1963). (In English)

Deuterons of 15 Mev were used to study the $Si^{28}(d,p)Si^{29}$ ground-state reaction involving the transfer of $l = 0$ neutrons. The conclusions reached on the basis of this study seem to be general enough to warrant a belief that they relate in some degree to most stripping processes in the higher-energy region. (C.E.S.)

21056 RESONANT GAMMA ABSORPTION NEAR CRYSTAL SURFACES. M. Rich (Los Alamos Scientific Lab., N. Mex.). Phys. Letters, 4: 153-5(Apr. 1, 1963). (LADC-5687). (In English)

The recoilless Mössbauer fraction is calculated for nuclei at various positions within a crystal to determine the difference between nuclei near the surface and in the interior. It is shown that changes in the recoilless fraction on the order of ten percent can occur depending on the location of the interacting atom with respect to the crystal surface. The recoilless fraction is decreased for sites near the surface. (C.E.S.)

21057 NUCLEAR COOLING BY ROTATION. F. N. H. Robinson (Clarendon Lab., Oxford). Phys. Letters, 4: 180-1(Apr. 1, 1963). (In English)

Nuclear polarization was observed in a crystal of $La_2Mg_3(NO_3)12\cdot 24H_2O$ by continuous rotation in a magnetic field at low temperatures. (C.E.S.)

21058 FAST DEUTERONS AND OTHER VERY LIGHT NUCLEI FROM HIGH ENERGY PROTON BOMBARDMENT OF MATTER. Črtomir Zupančič (Nuclear Institute "J. Stefan", Ljubljana, Yugoslavia). Phys. Letters, 4: 182-4(Apr. 1, 1963). (In English)

Several processes for the emission of fast light nuclei from high energy proton bombardment of matter are discussed. A mechanism is derived that qualitatively explains some increase of the deuteron to proton ratio with the nuclear radius. (C.E.S.)

21059 RADIATIVE CAPTURE OF DEUTERONS BY H^3. W. Buss, H. Waeffler, and B. Ziegler (Max-Planck-Institute for Chemistry, Mainz). Phys. Letters, 4: 198-9(Apr. 1, 1963). (In English)

Gamma rays of 17 Mev from the reaction $H^3(d,\gamma)He^5$ were observed. The thick target yield of γ rays was meas-

ured for 5 different deuteron energies between 150 and 1300 kev. The experimental curve was interpreted as a result of resonance capture and a direct capture process. The cross sections are given as a function of the energy of the captured deuterons. (C.E.S.)

21060 EFFECTS OF PARTICLE-HOLE EXCITATIONS IN NUCLEAR SCATTERING. R. H. Lemmer (Massachusetts Inst. of Tech., Cambridge). Phys. Letters, 4: 205-8 (Apr. 1, 1963). (TID-18087). (In English)

A simple model for the scattering of a particle by a nucleus A that takes into account the possibility of forming the compound states of the A + 1 particle target nucleus system is described. A situation in which the target states are adequately described by single-hole excitations and in which the compound states are formed by coupling the incident particle to these hole states is considered. (C.E.S.)

21061 COHERENT MAGNETIC SCATTERING OF THERMAL NEUTRONS BY COBALT AT HIGH TEMPERATURE. F. Menzinger and A. Paoletti (Centro di Studi Nucleari della Casaccia del Comitato Nazionale per l'Energia Nucleare, Rome). Phys. Rev. Letters, 10: 290-2(Apr. 1, 1963).

Preliminary results on the coherent magnetic scattering of thermal neutrons by face-centered cubic cobalt at high temperatures, which indicate either that magnetic electrons vibrate under thermal agitation with measurably less than the nuclear amplitude or that the magnetic form factor is appreciably temperature dependent, are reported. In diffraction experiments the thermal motion of the atoms in the lattice reduces the coherent scattering cross section with increasing temperatures. The temperature dependence of the magnetization for the $Co_{.92}$ $Fe_{.08}$ alloy was measured. (C.E.S.)

21062 NEW RESONANCES IN PHOTON TRANSITION STRENGTH FUNCTIONS. P. Axel, K. Min, N. Stein, and D. C. Sutton (Univ. of Illinois, Urbana). Phys. Rev. Letters, 10: 299-302(Apr. 1, 1963).

The strength function, which is the ratio of the average ground-state radiative width to the average level spacing, was displayed in the 135° quasi-elastic photon scattering cross sections of Pb^{206}, Bi^{209}, Sn, and Zr. The results from Pb^{208} show that for this special case the participating levels have spacings much greater than the experimental resolution. The cross sections measured include at each energy the unresolved contributions of many narrow, isolated nuclear energy levels. (C.E.S.)

21063 LIFETIME OF HELIUM HYPERFRAGMENTS. Y. W. Kang, N. Kwak, J. Schneps, and P. A. Smith (Tufts Univ., Medford, Mass.). Phys. Rev. Letters, 10: 302-4 (Apr. 1, 1963).

A stack of Ilford K5 nuclear emulsion was exposed in the 800 Mev/c K^- meson beam of the Bevatron to obtain information on hypernuclear lifetimes. Data concerning the lifetime of helium hyperfragments He^4 and He^5 are presented. (C.E.S.)

21064 THE DECAY OF $^{115}Cd^m$. J. B. Van Der Kooi, H. J. Van Den Bold, and P. M. Endt (Rijksuniversiteit, Utrecht). Physica, 29: 140-8(Feb. 1963). (In English)

In the decay of Cd^{115m} (43d) several new, very weak, γ transitions were observed in scintillation single spectra and coincidence spectra, with the following energies and intensities (in percents of the intensity of the 935 kev γ ray): 130 ± 5 (0.07), 162 ± 3 (1.3), (206 ± 6) (0.15), 292 ± 5 (0.2), 1130 ± 5 (5.2), and 1420 ± 15 kev (2.0). These γ rays fit into the known In^{115} level scheme if a new level is assumed at E_x = 1129 kev, excited through a 0.07% β^- transition. The γ-γ angular correlation was measured for the 485 to 935 kev cascade. From this measurement and from considerations on γ-ray intensities and β-ray ft values, spin and parity assignments of $\frac{7}{2}^+$, $(\frac{13}{2}^+)$, $(\frac{11}{2})^+$, and $\frac{9}{2}^+$ are made to the In^{115} levels at 935, 1129, 1290, and 1420 kev, respectively. These levels can be regarded as generated by the removal of a g proton from Sn^{116} in its first excited state ($J^\pi = 2^+$). From Lawson and Uretsky's center-of-gravity rule the excitation energy is estimated for the missing $\frac{5}{2}^+$ member of this quintuplet. (auth)

21065 THE RANGES OF NITROGEN IONS IN GOLD. W. R. Phillips and F. H. Read (Univ. of Manchester, Eng.). Proc. Phys. Soc. (London), 81: 1-8(Jan. 1, 1963).

The ranges and range distributions of N^{15} ions in gold were measured for incident-ion energies in the range 0.4 to 6.4 Mev, by observing the yield of a resonance in the $N^{15}(p,\alpha\gamma)C^{12}$ reaction. This technique can be extended to measurements on the stopping of other ions in solids. The experimental results are compared with theories of the slowing down of heavy ions and a satisfactory description of the stopping is presented in terms of these theories. (auth)

21066 THE EFFECTS OF DEGENERACY OF THE INELASTIC SCATTERING OF ELECTRONS AND PROTONS BY HYDROGEN ATOMS. P. D. Robinson (Oxford Univ.). Proc. Phys. Soc. (London), 81: 15-22(Jan. 1, 1963).

An investigation is made of the effects of 2s : 2p degeneracy on cross sections for the 1s → 2p and 1s → 2s excitation of hydrogen atoms by electron and proton impact. The initial relative energy ranges considered are 10.2 to 50 ev for electrons and 0.25 to 50 kev for protons. A simple rotating axis approximation of Bates is employed, and the degeneracy is allowed for by using spheroidal atomic wave functions in the matrix elements rather than pure 2s or 2p functions. These spheroidal functions are varying linear combinations of 2s and 2p, and are the correct zero-order functions for the atom perturbed by a charged particle. The degeneracy effects are measured by comparing the direct cross sections found using the pure 2s and 2p functions with the indirect cross sections obtained from the spheroidal functions. The indirect results are quite different from the direct ones for slow collisions, both for electron and for proton impact. Comparisons are made with the Born approximation, with certain more refined results of other authors, and (for electron impact) with the experimental evidence. The indications are that the indirect cross sections are the better for slow collisions, and it is concluded that allowance should certainly be made for degeneracy effects if accurate excitation cross sections are desired. (auth)

21067 DEACTIVATION OF METASTABLE HELIUM BY PROTON IMPACT. D. C. S. Allison and A. Dalgarno (Queen's Univ., Belfast). Proc. Phys. Soc. (London), 81: 23-7(Jan. 1, 1963).

The rate coefficient of the collision-induced radiation process $He(2^1S) + H^+ \rightarrow He(1^1S) + H^+ + h\nu$ is calculated for temperatures up to 16,000°K. The rate coefficient is nearly constant at a value between 2×10^{-11} and 4×10^{-11} cm^3 sec^{-1}. (auth)

21068 THE HYPERFINE STRUCTURE AND NUCLEAR MOMENTS OF ^{143}Nd AND ^{145}Nd. I. J. Spalding (Cavendish Lab., Cambridge, Eng.). Proc. Phys. Soc. (London), 81: 156-62(Jan. 1, 1963).

The atomic-beam magnetic-resonance technique was used to measure the hyperfine structure of the stable isotopes Nd^{143} and Nd^{145} in the ground state $4f^4$, $^5I_4$, and of

Nd^{145} in the metastable atomic state $^5I_5$. The values of the magnetic dipole and electric quadrupole interaction constants A and B are, for Nd^{143}, $A(^5I_4) = -195.649(9)$ Mc/s, $B(^5I_4) = +122.25(28)$ Mc/s, and for Nd^{145}, $A(^5I_4) = -121.627(27)$ Mc/s, $A(^5I_5) = -95.531(19)$, Mc/s, $B(^5I_4) = +64.60(37)$ Mc/s and $B(^5I_5) = +60.65(70)$ Mc/s. Our earlier g_J measurements for the ^5I multiplet indicated that the valence electrons were adequately described by Russell-Saunders coupling within a single configuration, and so Nierenberg's formulas for the hyperfine structure of a Hund's Rule ground term of equivalent electrons were used to calculate $A(^5I_5)/A(^5I_4) = +0.79129$ and $B(^5I_5)/B(^5I_4) = +0.9390$. These ratios agree well with experimental values. For $\langle r^{-3}\rangle_{4f} = 28.6$ A^{-3} (±10%), $\mu^{143} = -1.25(13)$ n.m., $\mu^{145} = -0.78(8)$ n.m., $Q^{143} = -0.57(6)$ bn and $Q^{145} = -0.30(3)$ bn, where the moments are not corrected for core polarization effects and the errors given in parenthesis are those due to the uncertainty in $\langle r^{-3}\rangle$ only. Neglecting hyperfine structure anomalies, which should be small for 4f configurations, the ratios $\mu^{143}/\mu^{145} = +1.60860(36)$ and $Q^{143}/Q^{145} = +1.893(16)$ can be deduced from our measurements of A and B. Existing theoretical work accounts adequately for the dipole ratio, but not for the measured ratio of the quadrupole moments. (auth)

21069 SPIN-DEPENDENT QUASI-ELASTIC SCATTERING OF FAST NUCLEONS. D. J. Hooton and N. W. Ashcroft (Victoria Univ., Wellington, N. Z.). Proc. Phys. Soc. (London), 81: 193-210(Feb. 1, 1963).

The distortion produced by a spin-dependent optical potential in the scattering and polarization of fast nucleons by light nuclei is discussed for the case of excitation of the target nucleus to a low-lying state. The distorted Born approximation is used, with the distortion calculated according to the WKB approximation. The results are applied to the scattering of protons at around 185 Mev from C^{12}, O^{16}, and Ca^{40}. The approximate equality of polarization and asymmetry is discussed in relation to the surface nature of the spin-orbit potential. (auth)

21070 THE $^{40}Ca(p,p')$ REACTION AT 150 Mev. D. J. Rowe, A. B. Clegg, G. L. Salmon, and D. Newton (Clarendon Lab., Oxford). Proc. Phys. Soc. (London), 81: 332-42 (Feb. 1, 1963).

Measurements are presented of gamma rays in coincidence with protons inelastically scattered from Ca^{40}, enabling determination of the states excited in the $Ca^{40}(p,p')$ reaction with good energy resolution. It is found that only a few states, the collective excitations of the ground state, are excited. The proton-gamma angular correlation in the excitation of the octupole vibration state at 3.73 Mev was measured. The results are discussed. (auth)

21071 THE PHOTOPRODUCTION OF π^0 MESONS IN HYDROGEN. D. B. Miller and E. H. Bellamy (Univ. of Glasgow). Proc. Phys. Soc. (London), 81: 343-8(Feb. 1, 1963).

Accurate absolute differential cross sections for the reaction $\gamma + p \rightarrow \pi^0 + p$ were measured at 90° in the center-of-mass system at 22 energies between 200 and 300 Mev for the incident photons by counting the protons at laboratory angles of 36° and 40.5° in the laboratory system. The protons were emitted from a thin hydrogen target exposed to the bremsstrahlung beam of the Glasgow synchrotron. The measurements agree with previously measured values at 200 and 300 Mev, but are about 30% lower near 250 Mev. The results were compared with dispersion relation calculations. (auth)

21072 COLLECTIVE MOTION IN THE NUCLEAR SHELL MODEL. III. THE CALCULATION OF SPECTRA. J. P. Elliott and M. Harvey (Southampton Univ., Eng.). Proc. Roy. Soc. (London), Ser. A, 272: 557-77(Apr. 9, 1963).

A method is derived for calculating matrix elements of a two-body interaction in wave functions that were classified in terms of the group U_3. For simplicity, a Cartesian basis of intrinsic functions is introduced in which the one-dimensional oscillators in x, y, and z are separately diagonal. An application to Mg^{24} in L-S coupling shows very little mixing of the quantum number K but an appreciable (10 to 20%) mixing of U_3 representations $(\lambda\mu)$. Overall agreement with experiment is quantitatively tolerable but the main pattern of the spectrum is undoubtedly given by the lowest representation. On this basis, suggestions are made concerning the type of spectra to be expected for even and odd parity levels of the even-even nuclei in the mass region $16 < A < 40$. (auth)

21073 CLUSTER-COUPLING SHELL MODEL FOR O^{16}. Isamu Sakama and Toyu Tani (Tokyo Inst. of Tech.). Progr. Theoret. Phys. (Kyoto), 28: 1100-2(Dec. 1962). (In English)

A cluster-coupling shell model is presented that explains the electric monopole transition between the wave functions and gives reasonable values of the excitation energies of the low-lying levels in O^{16}. (C.E.S.)

21074 EFFECTIVE HAMILTONIAN AND ENERGY GAP IN FINITE NUCLEI. Hiroharu Bandō (Kyoto Univ.), Toshiyuki Murota, and Sinobu Nagata. Progr. Theoret. Phys. (Kyoto), 29: 221-34(Feb. 1963). (In English)

An effective hamiltonian is derived for finite nuclei from the original one that contains a hard-core interaction. The former has a screened hard-core interaction and is used to treat the phenomena near the ground state of the nuclei. Thus it gives a base for the calculation in the shell model. As an example, the energy gap is calculated for Ni^{60} by applying Bogoliubov's method to the effective hamiltonian. (auth)

21075 APPLICATION OF DISPERSION RELATIONS TO LOW ENERGY KAON SCATTERING IN NUCLEI. Kosai Tanabe (Tokyo Univ.). Progr. Theoret. Phys. (Kyoto), 29: 255-67(Feb. 1963). (In English)

The dispersion relations for the forward scattering amplitudes are applied to estimate the nuclear many-body effect to the amplitudes that describe the kaon-nucleon scattering in nuclei and to obtain an optical model potential. The analysis is made of the assumption that only the effect of the Pauli principle to the intermediate states of the process plays a significant role and that of the multiple scatterings can be neglected. It is shown that, if the Y^* resonant states consist of the $\bar{K}$-N bound systems, in nuclei the K^--p forward scattering amplitude can be positive at low energies, i.e., effectively attractive potential even if the Dalitz-Tuan (–) solutions are adopted for the free K^--p scattering. (auth)

21076 DETERMINATION OF INDIVIDUAL YIELDS OF A = 139 ISOBAR IN URANIUM FISSION BY 14-Mev NEUTRONS. A. N. Apollonova, I. T. Krisyuk, and V. N. Ushatskii. Radiokhimiya, 4: 587-91(1962). (In Russian)

An isobar series A = 139 expressed by I_{53}^{139}(2.7 sec) → Xe_{54}^{139}(41 sec) → Cs_{55}^{139}(9.5 min) → Ba_{56}^{139}(85 min) → La_{57}^{139} (stable) was studied in U fission by 14-Mev neutrons. The yield for I^{139} and Xe^{139} was 18.3 and 47.5%, respectively. A total curve was constructed for A = 139 mass fractions. A symmetric curve corresponding to the Gaussian distribution with a half-width of two charge units, and a maximum point at Z = 54.16 was obtained. (R.V.J.)

21077 ALPHA DECAY OF Pu-241. B. S. Dzhelepov, R. B. Ivanov, A. S. Krivokhatskii, and V. G. Nedovesov. Radiokhimiya, 4: 619-20(1962). (In Russian)

A double-focusing α spectrometer was used in studies of Pu^{241} α emission. The five groups of α particles (their energies, relative intensities, and forbiddenness factors) are tabulated. (R.V.J.)

21078 MEASUREMENT OF LOW-ENERGY NEUTRON-CAPTURE RADIATION FROM Re^{186} AND Re^{188}. Otto W. B. Schult, Bernd Weckermann, Till v. Egidy, and Erhard Bieber (Technische Hochschule, Munich). Z. Naturforsch., 18a: 61-5(Jan. 1963). (In German)

A crystal-spectrometer was used for the measurement of neutron capture γ rays of Re^{186} and Re^{188} within the energy range of 30 and 350 (resp. 210) kev. A sudden decrease in intensity was found for both 69.5 and 105.8 kev lines of Re^{188m} when the reactor was shut off. This fact, coincidence measurements and measurements with a scintillation spectrometer cannot be explained on the base of the level schemes given in the Nuclear Data Sheets nor the tables of Landolt-Börnstein or Kunz-Schintlmeister. The investigation of the conversion-electron spectrum showed the 63.5 and 105.8 kev transition to be of M1-type. The KL_1 X-radiation was $(1.9 \pm 0.7) \times 10^{-3}$ times as intense as the $K\alpha_1$-radiation. (auth)

21079 THE MAGNETIC MOMENT OF THE 2.083 Mev TWO-PROTON LEVEL OF THE EVEN-EVEN NUCLEUS Ce^{140}. H. J. Koerner, E. Gerdau, C. Guenther, K. Auerbach, G. Mielken, G. Strube, and E. Bodenstedt (Universität, Hamburg). Z. Physik, 173: 203-20(1963). (In German)

The nuclear g-factor of the 2.083-Mev state of Ce^{140} was determined as: $g = 1.11 \pm 0.04$. This value suggests the interpretation of the level as the $(g_{7/2},d_{5/2})_4$ two proton shell model configuration. The investigation implies an integral measurement as well as a time dependent differential measurement (spin rotation method) of the rotation of the 329 kev–487 kev $\gamma\gamma$-angular correlation in strong external magnetic fields. Liquid sources of lanthanum nitrate solved in 3N HNO_3 were used in these experiments. Some cerium (IV) nitrate was added to make sure that the 4f-electronic shell remained empty after the β^- decay. This prevented paramagnetic effects. Additional runs were performed without adding cerium (IV) nitrate and finally by using liquid sources of lanthanum chloride solved in 2N HCl with some iron (II) chloride added. It was expected that the Fe^{2+} ions would reduce the primarily formed Ce^{4+} ions into the Ce^{3+} state. The Ce^{3+} shell is paramagnetic and enlarges the effective magnetic field at the position of the nucleus by about 36%. As no definitely faster rotation could be observed, it was concluded that the ion reaction $Ce^{4+} + Fe^{2+} \rightleftarrows Ce^{3+} + Fe^{3+}$ takes more than about 10^{-9} sec. The half life of the 2.083 Mev state was redetermined as $T_{1/2} = (3.41 \pm 0.04) \times 10^{-9}$ sec. Differential measurements of the angular correlation of the 329 kev–487 kev cascade as a function of the time delay showed that perturbations by internal fields were very small. The coefficients A_2 and A_4 of the angular correlation and the attenuation parameter λ_2 were determined from measurements with sources of the first type as: $A_2 = -0.105 \pm 0.003$, $A_4 = -0.001 \pm 0.002$, and $\lambda_2 = (0.0065 \pm 0.0040) \times 10^9$ sec^{-1} $= (0.032 \pm 0.020) \times \lambda$. A comparison with the theoretical coefficients of a (3- 4-2)-cascade shows that the multipolarity of the 329 kev radiation is a mixture of 99.83% M1 and (0.17 ± 0.03)% E2. (auth)

21080 ON THE DIFFERENCE OF TWO PEAKS IN MÖSSBAUER QUADRUPOLE SPLITTING SPECTRA. V. I. Gol'danskii, E. F. Makarov, and V. V. Khrapov (Inst. of Chemical Physics, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 752-5(Feb. 1963). (In Russian)

An analysis is made of three postulates for explaining the difference of the two peaks in Mössbauer doublet splitting spectra observed in $Sn(C_6H_5)_3Cl$, SnO, and some iron compounds. The postulation that asymmetry of doublet Mössbauer lines is caused by superimposed singlet lines of two chemical forms or that it is caused by anisotropic crystal orientation in relation to the γ quanta are rejected in favor of a third postulation that states that quadrupole Mössbauer splitting in isotropic polycrystal should generally have various peaks, except for specific cases in which the isotropic Mössbauer effect is symmetric. This was previously proved by tests using Mössbauer anisotropic effect in corresponding monocrystals. The asymmetry of two peaks was analyzed in $Sn(C_6H_5)_3$-Cl and in other isotropic and anisotropic specimens at two angles to the γ quanta. The results confirm the third postulation on the Mössbauer anisotropy. (R.V.J.)

21081 ON SOME TRANSFER REACTIONS OCCURRING DURING IRRADIATION OF THORIUM BY Ne^{22} IONS. G. Kumpf and E. D. Donets. Zh. Eksperim. i Teor. Fiz., 44: 798-803(Mar. 1963). (In Russian)

Reactions in which a large number (from 5 to 8) of nucleons are transferred under the action of heavy ions are investigated. Th^{232} targets were irradiated by Ne^{22} ions and the α-active Th^{227}, Ac^{226}, Ac^{225}, and Ac^{224} products were recorded. The dependences of the cross sections for production of these isotopes on the incident ion energies were measured. They gradually rise from 10^{-30} cm^2 near the Coulomb barrier to $\sim 10^{-27}$ cm^2 at an energy 154 Mev. Angular distributions of recoil nuclei of the indicated isotopes are obtained at energies of 150 and 120 Mev. They are peaked near the Rutherford angle. The positions of the peaks of the various isotopes are different, the larger the number of transferred nucleons, the larger the angle corresponding to the maximum of the cross section. The dependences measured cannot be described by existing models of the mechanism of transfer reactions. (auth)

21082 FORMATION OF NUCLEI WITH AN ANOMALOUS SPONTANEOUS FISSION PERIOD IN REACTIONS INVOLVING HEAVY IONS. S. M. Polikanov, T'ung-Sêng Wang, Kh. Kekk, V. L. Mikheev, Yu. Ts. Oganesyan, A. A. Pleve, and B. V. Fefilov. Zh. Eksperim. i Teor. Fiz., 44: 804-7(Mar. 1963). (In Russian)

The interactions of heavy ions (Ne, O, B) with uranium nuclei that lead to the formation of a spontaneously fissioning isotope with an anomalously small decay lifetime are investigated. The yield curves for the spontaneously fissioning isotope in various reactions are obtained and the half life is measured. It is suggested that transfer reactions occur with the Ne and O ions and that the atomic number of the unknown isotope is $Z \leq 97$. (auth)

21083 EXCITATION FUNCTION FOR THE (γ,p) REACTION ON TUNGSTEN. V. G. Shevchenko, B. A. Yurev, and B. P. Levkin (Moscow State Univ.). Zh. Eksperim. i Teor. Fiz., 44: 808-10(Mar. 1963). (In Russian)

The yield of the (γ,p) reaction on tungsten is measured for $E_{\gamma max}$ between 15.5 and 33.5 Mev by recording photoprotons with a CsI(Tl) crystal scintillation spectrometer. The dependence of the (γ,p) cross section on the γ energy, derived from the yield curve by the Penfold–Leiss matrix method, exhibits maxima at ~20.5 Mev (2.2 mb) and ~28 Mev (4.3 mb). An analysis indicates that the more pronounced peak at ~28 Mev is mainly caused by E2-absorption, whereas the 20.5 Mev peak is due to E1- as well as

E2-transitions. The integral cross section for the (γ,p) reaction up to 33 Mev is 50 ± 10 Mev · mb. (auth)

21084 STRIPPING REACTION ON Mo^{97} AND Te^{125}. N. I. Zaika and I. E. Sanzhur (Inst. of Physics, Academy of Sciences, Ukrainian SSR). Zh. Eksperim. i Teor. Fiz., 44: 823-4(Mar. 1963). (In Russian)

The angular distributions of protons from the (d,p) reactions on Mo^{97} and Te^{125} are measured for 13.6 Mev deuterons. The angular momenta transferred to the nucleus are determined. The angular distributions of protons characterized by $l_n = 0$ are compared for nuclei with atomic masses ranging from 12 to 125. (auth)

21085 INTERACTION OF A HIGH-ENERGY MULTICHARGED PARTICLE WITH A PHOTOGRAPHIC EMULSION NUCLEUS. Kh. P. Babayan and N. A. Marutyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Zh. Eksperim. i Teor. Fiz., 44: 832-9(Mar. 1963). (In Russian)

A unique interaction event of the 16 + 201 Z type between a multicharged particle with an energy of 3×10^{11} ev per nucleon and a nucleus in a photographic emulsion is investigated. Because of the high multiplicity of the interaction and also the convenient position of the event in the photographic emulsion, it was possible to obtain sufficiently good statistics for observing the correlation between the emission angle and the transverse momentum of the secondary particles in the small angle region ($\theta_i < 4°$). A correlation coefficient of 0.81 was obtained. The transverse momentum distribution is consistent with that previously obtained for secondary particles produced in nucleon-nucleon and nucleon-nucleus interactions. The mean transverse momentum is found equal to 215 Mev/c. The angular distribution satisfactorily agrees with the hydrodynamic theory. (auth)

21086 MÖSSBAUER EFFECT ON Sn^{119} NUCLEI AND AN ATTEMPT TO DETECT THE EFFECT IN Pr^{141}. V. A. Bukarev (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 852-7(Mar. 1963). (In Russian)

Isomer energy shifts of the 23.8-kev γ rays from Sn^{119m} are determined for several tin compounds, $Na_2SnO_3 \cdot 3H_2O$, $SnBr_4$, $SnSO_4$, etc. Quadrupole splitting was found in a number of compounds (e.g., SnO_2, $SnCl_2 \cdot 2H_2O$, etc.). The lower limit of variation of the effective charge radius of the Sn^{119} nucleus in the excited state is $\Delta R/R \geq +0.8 \times 10^{-4}$. No resonance absorption effect was found for the 145 kev γ transition $7/2^+ \rightarrow 5/2^+$ in Pr^{141} nuclei in the range ±8 mm/sec. (auth)

21087 PRODUCTION OF HYPERNUCLEI BY 8.8-Bev PROTONS. M. E. Arustamova, A. R. Kanetyan, M. G. Sarinyan, R. T. Toshyan, V. A. Tumanyan, and E. R. Tumanyan (Inst. of Physics, Academy of Sciences, Armenian SSR). Zh. Eksperim. i Teor. Fiz., 44: 861-5(Mar. 1963). (In Russian)

The production of hypernuclei by ~9 Bev protons is investigated. 132 decay events of hypernuclei were detected. $_\Lambda B^{10}$ and $_\Lambda Be^{11}$ hypernuclei were observed for the first time. (auth)

21088 ANGULAR DISTRIBUTION OF PARTICLES FROM THE $O^{18}(p,\alpha_0)N^{15}$. K. V. Karadzhev, V. I. Manko, and F. E. Chukreev. Zh. Eksperim. i Teor. Fiz., 44: 870-7(Mar. 1963). (In Russian)

The angular distributions of particles emitted in the $O^{18}(p,\alpha_0)N^{15}$ reaction are studied for angles between 30 and 150° (laboratory system) and for proton energies between 730 and 1050 kev. The experimental data are analyzed on basis of the resonance theory of nuclear reactions. The spin and parity and partial reduced widths for the 8.89 Mev level in the F^{19} nucleus are respectively found to be $1/2^+$, $\Theta_p^2 = 2.4 \times 10^{-4}$, $\Theta_\alpha^2 = 5.5 \times 10^{-3}$. It is concluded that with a high probability α associations of nucleons are formed in the F^{19} nucleus in this state. (auth)

21089 PHOTOPRODUCTION OF NEUTRAL MESONS ON NUCLEI NEAR THE THRESHOLD. B. B. Govorkov, S. P. Denisov, and E. V. Minarik (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 878-86(Mar. 1963). (In Russian)

Results are presented on the measurement of the angular dependence of the π^0 photoproduction cross section on Be, Al, Cu, Cd, and Ta nuclei for 154 Mev mean primary photon energies. The π^0 mesons were observed by recording coincidences of $\pi^0 \rightarrow \gamma + \gamma$ decay γ quanta with aid of two scintillation telescopes. An analysis of the results obtained shows that the main contribution to the cross section is from elastic coherent photoproduction. (auth)

21090 ELASTIC SCATTERING OF 26–33 Mev He^3 ON C, Na, Mg AND Al NUCLEI. V. M. Pankratov and I. N. Serikov. Zh. Eksperim. i Teor. Fiz., 44: 887-93(Mar. 1963). (In Russian)

Experimental results on the differential cross sections for elastic scattering of He^3 on C, Mg, and Al nuclei are presented for six energy values lying between 26 and 33 Mev and for the two energies 25.7 and 32.8 Mev for scattering on Na. The angular dependence of the cross sections has a pronounced diffractional structure. The energy dependence is manifested in variation of the absolute values of the cross sections and in the angular shift of the diffraction maxima. For each of the nuclei the interaction range computed on basis of diffraction on a black disc is found to be constant in the investigated energy range. (auth)

21091 DIFFRACTION MECHANISM OF THE INVERSE $\pi \rightarrow \mu + \nu$ DECAY IN THE FIELD OF A NUCLEUS. Yu. P. Nikitin. Zh. Eksperim. i Teor. Fiz., 44: 957-61(Mar. 1963). (In Russian)

The $\nu + A \rightarrow \pi + \mu + A$ process is studied for high energy neutrinos. It is shown that the main contribution to this process is due to strong interaction between the meson and nucleus that can be taken into account phenomenologically by the formulas for diffraction on a black sphere. (auth)

21092 CALCULATION OF THE ENERGY AND ANGULAR CHARACTERISTICS OF MULTICHARGED PARTICLES PRODUCED BY HIGH ENERGY PROTONS. M. M. Makarov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Eksperim. i Teor. Fiz., 44: 962-8(Mar. 1963). (In Russian)

The energy spectra of multicharged particles emitted at a given angle and their angular correlations with the scattered protons are calculated with an electronic computer. The dependence of these characteristics on the proton beam energy, momentum distribution in the nucleus, emission angle, binding energy, and mass of the multicharged particles is investigated. The results of the calculations are compared with the experimental data and it is shown that the cascade theory presently developed corresponds to the experiments. (auth)

21093 COALESCENCE OF PHOTONS IN THE COULOMB FIELD OF NUCLEI. E. A. Kuraev and S. S. Sannikov (Inst. of Physics and Tech., Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 1015-22(Mar. 1963). (In Russian)

Expressions are deduced for the probability of photon coalescence in the Coulomb field of nuclei. The expressions are obtained for the limiting cases of large and small photon frequencies as compared to the electron mass. Coalescence of photons in the high frequency region is investigated by the dispersion relation method. The low frequency range is investigated by introducing radiative

corrections to the Lagrangian function of the electromagnetic field. (auth)

21094 DETERMINATION OF NUCLEAR MATRIX ELEMENTS IN THE NON-UNIQUE FIRST FORBIDDEN BETA-DECAY OF Eu^{152}, Eu^{154}, AND Sb^{124}. Kandula Sita Rama Sastry. Thesis, Bloomington, Ind., Indiana Univ., 1962. 138p.

The energy dependence of the β-γ directional correlation involving the outermost non-unique first forbidden β-ray groups in the decay of Eu^{152}, Eu^{154}, and Sb^{124} and the cascade E2 γ-rays in the daughter nuclei has been measured using a β-γ coincidence spectrometer of the "slow-fast" type with a coincidence resolving time of 30–40 nanoseconds. A small shaped field magnetic spectrometer with 5% resolution and transmission is used for β-ray momentum selection. The data indicate that these transitions are predominantly governed by the B_{ij} matrix element of rank 2. A general method of analysis, applicable to the β-γ directional and circular polarization correlation data, is developed by combining a least squares analysis of the data with the complete theoretical expressions of Kotani for these observables. It is shown that a knowledge of the three observables C(W), ϵ, and P_c (the degree of circular polarization of the γ ray) is adequate for a unique determination of the nuclear parameters. The matrix elements thus obtained from this analysis are given. All the matrix elements are reduced by a factor of 10 to 1000 from the values expected for a perfect overlap of the initial and final state nuclear wave functions, the rank one matrix elements being retarded much more than the rank two, indicating that a selection rule rather than cancellation effect is responsible for the deviation from the ξ-approximation in these transitions. The j-selection rule seems to be operative in Sb^{124} while the K-selection rule appears to inhibit the decay of Eu^{154}. The selection rule effect in the decay Eu^{152}–Gd^{152} is not clear because K is not a good quantum number in this case involving a transition from a deformed to a spherical nucleus. (A.G.W.)

21095 THE POLARIZATION OF THE RADIOACTIVE NUCLEUS SODIUM 21, THROUGH OPTICAL PUMPING. John Talbot Sibilia. Thesis, Princeton, N. J., Princeton Univ., 1962. 184p.

Several attempts were made to measure the Zeeman resonance frequencies of the short-lived isotope sodium 21, which would allow the computation of the spin and nuclear magnetic dipole moment of its nucleus. Two distinct approaches to this problem were taken: the optical detection of the change in opacity of a scattering cell containing very dilute sodium 21 in neon, and the observation of an asymmetry in the angular distribution of positrons resulting from the beta decay of this nucleus. The first technique was unsuccessful because the signal-to-noise ratio was below unity for the number of sodium 21 atoms that could be produced, in spite of a very sensitive detection system. In the beta-decay experiment an asymmetry was observed in the angular distribution of the positrons eminating from a pumped sample. The magnitude of this asymmetry corresponding to an "a" of 0.008 in the theoretical $(1 + a \cos \theta)$ distribution was not sufficiently large to allow the reliable observation of change when resonant r-f was applied to the sample. This asymmetry is, however, direct evidence of nuclear polarization through optical pumping. The reasons for this low asymmetry coefficient are presented, and it is shown that a suitable optical filter should render either experiment successful. The production and handling of sodium 21 is discussed in detail and considerable information concerning the adherence of sodium to various materials is presented. The theory of optical pumping and the theory of the beta decay of polarized nuclei are considered. Estimates of obtainable signal-to-noise ratios for this type of experiment are developed. (Dissertation Abstr. XXIII, No. 8)

21096 A PRECISE COMPARISON OF THE NEUTRON THRESHOLD ENERGY AND THE Q-VALUE OF THE $Li^7(p,n)Be^7$ REACTION. Frank Coleman Young. Thesis, College Park, Md., Univ. of Maryland, 1962. 67p.

Since the $Li^7(p,n)Be^7$ reaction is endoergic, there is a threshold energy for the incoming protons corresponding to the onset of the reaction. For protons with energies immediately above the threshold energy, the outgoing neutrons are emitted into a cone about the forward direction. The angle of this cone depends on the proton energy, the Q of the reaction, and the masses of the nuclei involved. A determination of this angle enables one to calculate the Q-value of the reaction if the energy of the incident protons is known. The cone-angle was measured for the $Li^7(p,n)Be^7$ reaction at a proton energy 20 kev above the threshold energy. The proton energy was determined relative to the energy at which (neutron yield)$^{\frac{1}{2}}$ extrapolates to zero. The neutron yield was calculated by assuming an isotropic distribution for the neutrons in the center-of-mass system. With a beam spread of 240 ev and a detector resolution of 0.7°, the cone-angle was measured to an accuracy of 0.2°. If 1880.6 ± 0.4 kev is taken for the fixed-energy calibration point, the cone-angle determination gives $Q = -1644.38 \pm 0.17$ kev relative to this energy point taken with no error. The threshold energy corresponding to this Q-value is 1880.7 ± 0.2 kev. Hence it is concluded that within the experimental uncertainty the direct threshold determination and the cone-angle measurement give the same result for the Q-value. (A.G.W.)

21097 A STUDY OF TWO NUCLEON STRIPPING AND TWO NUCLEON PICKUP REACTIONS IN LIGHT NUCLEI. Chris Dan Zafiratos. Thesis, Seattle, Univ. of Washington, 1962. 94p.

(α,d) and (α,Li^6) reactions on light elements leading to low excitations of the residual nucleus have been studied using 42-Mev incident alpha particles. The (α,d) reactions studied were $Be^9(\alpha,d)B^{11}$, $B^{10}(\alpha,d)C^{12}$, $B^{11}(\alpha,d)C^{13}$ and $N^{14}(\alpha,d)O^{16}$. The (α,Li^6) reactions studied were $C^{12}(\alpha,Li^6)B^{10}$ and $N^{14}(\alpha,Li^6)C^{12}$. It was concluded that these reactions proceed primarily via a direct, rather than compound nuclear, reaction mechanism. A reduced total cross section for each reaction was obtained and compared. It was found that the (α,d) reaction on B^{10} and N^{14} was enhanced over neighboring cases. Further, the $N^{14}(\alpha,Li^6)C^{12}$ reaction was enhanced considerably over $C^{12}(\alpha,Li^6)B^{10}$. These results are in qualitative agreement with the cluster model of the nuclei. (Dissertation Abstr. XXIII, No. 8)

21098 THE (α,Be^7) REACTION IN LIGHT ELEMENTS AT ENERGIES BELOW 42 Mev. Charles Oliver Hower, Jr. Thesis, Seattle, Univ. of Washington, 1962. 137p.

The production of Be^7 from the 42-Mev helium ion bombardment of light elements has been studied. Catcher foil techniques were used to determine the angular distributions and energy distributions of Be^7 fragments from oxygen and aluminum. The results are consistent with a compound nucleus mechanism for the reactions $O^{16}(He^4,Be^7)C^{13}$ and $Al^{27}(He^4,Be^7)Na^{24}$. An attempt was made to study the latter reaction through observation of the Na^{24} residual nucleus. The results were inconclusive because of the possible presence of an interfering reaction, $Al^{27}(He^4,\alpha He^3)Na^{24}$, which could not be distinguished from the reaction of interest. Cross section measurements were made for Be^7

production from the helium ion bombardment of carbon, nitrogen, oxygen, fluorine and neon. The cross section data are interpreted in terms of the statistical theory. The range-energy relationship for Be^9 ions in gold and aluminum has been determined by a pulse height analysis method. Measurements were made in the energy range of 2 to 21 Mev. An ionization chamber is described which was used for the identification of Li, Be, and B fragments from nuclear reactions. Some preliminary results obtained with the chamber are reported. (Dissertation Abstr. XXIII, No. 8)

21099 THE INELASTIC PROTON-GAMMA ANGULAR CORRELATION OF C^{12} AT 40 Mev. Harry Stanley Adams. Thesis, Minneapolis, Univ. of Minnesota, 1962. 74p.

The angular correlation function between the de-excitation gamma ray and protons inelastically scattered from the first excited state (4.43 Mev) in C^{12} was measured for six different proton scattering angles. These angles were 18, 30, 45, 60, and 110 degrees in the laboratory system. The angular correlation function was found to be of the form $W(\theta_\gamma) = A + B \sin^2 2\theta_\gamma - \theta_s)$ where θ_s is the symmetry angle and was found to be approximately, but not exactly, equal to the classical recoil angle. The A/B ratio was found to be approximately equal to 0.5. Measurements were also taken for the azimuthal angular correlation function. The data were analyzed using the distorted wave Born approximation of Levinson and Banerjee. Distorted waves are required to fit the angular correlation function between the de-excitation gamma ray and the inelastically scattered proton from the first 2^+ state in C^{12} when the incident proton energy is 40 Mev. The azimuthal correlation functions are also best explained using the distorted wave theory. Within the framework of the Levinson-Banerjee theory the A/B ratio shows that the nuclear wavefunctions describing the ground and first excited state of C^{12} are close to the extreme j-j coupling limit. (Dissertation Abstr. XXIII, No. 8)

21100 ON THE EXISTENCE OF A CHARGE DEPENDENT FORCE IN LIGHT NUCLEI. Albert Altman. Thesis, College Park, Md., Univ. of Maryland, 1962. 107p.

Criteria are established (called the isospin ratio and addition rules) for testing charge independence by comparing nucleon reduced widths of T = 1 levels in isospin triads. A charge dependent nuclear potential has been suggested by Blin-Stoyle and Le Tourneux as a mechanism which might explain the decrease in the Fermi nuclear matrix element for the beta decay $O^{14}(O^+,T = 1) \rightarrow N^{14}(O^+,T = 1)$ needed to resolve the discrepancy between the beta and μ-decay polar vector coupling constants. The low lying states of the A = 14 nuclei are analyzed within the framework of the shell model using the wave functions obtained by Visscher and Ferrell. The Coulomb energy shift between the members of the lowest lying T = 1 isospin triad are calculated and place constraining conditions on both the charge symmetric and charge asymmetric terms of the charge dependent nuclear potential. The energy shifts due to the difference in the spin orbit coupling parameter for C^{14} and O^{14}, and the difference in the ft value for the beta transitions of C^{14} and O^{14} to the ground state of N^{14} are calculated and place constraining conditions on the charge asymmetric terms of the charge dependent nuclear potential. The neutron-proton, proton-proton singlet scattering length difference places another constraint on the charge symmetric terms of the charge dependent nuclear potential. The parameters of the charge dependent nuclear potential are determined and their sensitivity to the shell model spring constant is studied. It is found that the charge symmetric terms are not sensitive to the spring constant. Although the asymmetric terms are sensitive to the spring constant their order of magnitude is bounded. The charge dependent nuclear potential is then used in the analysis of the Fermi matrix for the O^{14} beta decay and the deviation of M_F^2 from the charge independent value of 2 is three orders of magnitude too small to explain the current unresolved discrepancy of 2% between the experimental value of the μ-meson lifetime and the theoretical value obtained from the universal conserved vector current theory. (A.G.W.)

21101 THE HYPERFINE STRUCTURE AND ISOTOPE SHIFTS IN THE 2537-A LINE OF MERCURY BY A NEW INTERFEROMETRIC METHOD. Walter Gareld Schweitzer, Jr. Thesis, College Park, Md., Univ. of Maryland, 1962. 124p.

A new optical method for the precise determination of hyperfine structure and isotope shifts was developed. This method permits interferometric measurements on the absorption spectrum of an atomic beam. The use of balanced photoelectric detectors, with the atomic beam in one branch, allows the absorption fringes to be recorded as if they were emission fringes. Since the spectral width of the lines from the beam is much narrower than that from a more conventional source it is possible to separate components in the structure which would otherwise overlap badly. The selective method of excitation, accomplished by means of a source of a single isotope operated in a magnetic field, allows the various hyperfine components to be recorded one at a time, or at worst a few at a time. These features permit the use of long interferometers (ours were about 218 mm) of high resolving power where the whole order difference between two of the components may be very large. This technique has been applied with great success to the 2537-A line of mercury. The isotope shifts have been measured with a precision unequalled by any previous experiments. The hyperfine structure of the odd isotopes has been measured with equal precision, though in this case the precision is less than that which has been achieved by radio frequency, double-resonance experiments. Our results are in complete agreement with the double-resonance results, a fact which gives added confidence in our isotope shift results. (A.G.W.)

21102 QUASI-DEUTERON PRODUCTION BY γ-RAYS IN ^{4}He. Arne Reitan (NORDITA, Copenhagen). Preprint No. 4. 12p.

Paper from Proceedings of the Physics Seminar in Trondheim, 1962.

The total cross section for direct absorption of γ rays by neutron-proton pairs is evaluated for helium on the assumption of shell-model initial-state wave functions. Electric dipole and quadrupole as well as magnetic dipole transitions are taken into account. The results are compared with the corresponding experimental cross section. (auth)

21103 CONVERSION TRANSITIONS WITH PAIR PRODUCTION. V. A. Krutov and V. G. Gorshkov. p.508-22 of "Gamma-Luchi." Moscow-Leningrad, Publishing House of the Academy of Sciences, 1961.

The results of all previous calculations, precise and approximate, performed for the pair conversion coefficient without taking account of nuclear finite dimensions and shielding, are presented. Diagrams of the energy and angular distributions of the pair conversion coefficient, calculated in zeroth, first, the second Born approximations over the Coulomb field of the nucleus, are considered. E0 transitions and conversion transitions with monochromatic

positron production were also analyzed. (Referativnyy zhurnal, Fizika, No. 7, 1962)

Particle Accelerators

21104 (ANL-6700) HANDBOOK FOR THE NANOSECOND ELECTRON ACCELERATOR (NSEA). Eugene A. Mroz, Warren L. Buck, Robert K. Swank, and H. Bruce Phillips (Argonne National Lab., Ill.). Mar. 1963. Contract W-31-109-eng-38. 143p.

As an aid to prospective users of the device, the electron accelerator, the detection system, and the readout equipment are described; and the operational procedures followed are explained. Maintenance instructions are also given, as are diagrams of many components. The apparatus was designed mainly for studying scintillation decay times in the nsec region. (D.C.W.)

21105 (CEA-1936) UNE VANNE ELECTROMAGNETIQUE A PASSAGE DIRECT UTILISEE DANS LES ACCELERATEURS DE PARTICULES. (A Direct Passage Electromagnetic Valve Used in Particle Accelerators). B. Olkowsky, J. Guillo, and P. Sautejeau (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 5p.

An electromagnetic valve used to isolate the target area of an accelerator from the rest of the machine when air is entering the target chamber is described. The valve, used in the Van de Graaff machines and cyclotron of Saclay since 1957, offers quasi-instantaneous self-closing under the effects of the vacuum. (D.C.W.)

21106 (CEA-2227) CONSTRUCTION DE BOBINES SANS FER POUR LES ACCELERATEURS FFAG. (Construction of Core-Less Coils for FFAG Accelerators). Maurice Cotte (Paris. Université) and Duc Tien Tran (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 28p.

A calculation method for the determination of the coreless coil of an accelerator having a constant field and radial sectors is proposed. In the free space without current, reserved for the vacuum chamber, the Laplace equation $\Delta\vec{A} = 0$ was solved, where A is the potential vector defined in terms of the magnetic induction $\vec{B}$ as $\vec{B} = \text{rot } \vec{A}$. In the coil itself on the other hand, the equation that has to be resolved is that of Maxwell, rot rot $A = \mu_0\vec{j}$, where $\vec{j}$ is the current density that is considered to be the unknown of the problem. The supplementary condition is that the magnetic induction becomes zero in the same way outside the coil and outside the effective vacuum chamber volume. Our calculation consists in the determination of $\vec{\mathcal{A}}$ from $\vec{A}$ using a relationship of the form $\vec{\mathcal{A}} = F(x,y,z;\lambda) \cdot \vec{A}$, where F is either a squared diagonal matrix of the 3rd order, or a scalar function, as in the particular case studied; λ is a parameter or a set of parameters linked to the geometry of the coil. A coil having a simple shape was studied, and the lines of current were traced. (auth)

21107 (MURA-661) ON THE STABILITY LIMIT OF ORBITS IN A SPIRAL MAGNETIC FIELD. W. N. Wong (Midwestern Universities Research Assn., Madison, Wis.). Dec. 12, 1962. Contract AT(11-1)-384. 56p.

The general behavior of plane orbits in a simple spiral magnetic field is studied both analytically and numerically (for a specific sample case). Techniques employed are heavily geometrical in nature, and the motivation is the search for some simple conditions in the field parameters which control orbit stability and orbit economics. Pragmatic simplicity dictates a choice of approach which is only justified by a final numerical test, but reasonable rigor is accorded the fundamental equations. (auth)

21108 (SLAC-5) SOME ASPECTS OF THE PROSPECTIVE EXPERIMENTAL USE OF THE STANFORD TWO-MILE ACCELERATOR. W. Chinowsky, J. W. DeWire, D. B. Lichtenberg, G. Masek, J. J. Murray, M. Perl, M. Schwartz, J. Tinlot, and G. Trilling (Stanford Univ., Calif. Stanford Linear Accelerator Center). 1962. Contract AT(04-3)-400. 239p.

Eleven papers dealing with photon beams from the accelerator, use of hydrogen bubble chambers and spark chambers, a storage ring for 10-Bev muons, muon beams and μ-p scattering experiments, mass analysis of high-energy accelerator beams, the search for intermediate bosons and heavy leptons, particle yields arising from decay of short-lived intermediate particles, and conjectures on the effects of Regge poles on Drell processes are included. Separate abstracts were prepared for the eleven papers. (D.C.W.)

21109 (SLAC-5(p.1-19)) PHOTON BEAM FROM PROJECT M ACCELERATOR. J. W. DeWire (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Problems connected with deriving a useful photon beam from the accelerator while the electron beam is being used are discussed. Use of a monocrystal radiator to obtain a spectrum having sharp discontinuities is particularly examined, and several interference spectra for diamond monocrystals are calculated. Maintenance of sharpness and stability of the discontinuities is considered, and electron contamination of the diamond spectrum is found insignificant. A single-channel symmetrical-pair spectrometer is shown to be unacceptable as a continuous beam monitor. (D.C.W.)

21110 (SLAC-5(p.20-8)) CONJECTURES ON THE EFFECTS OF REGGE POLES ON DRELL PROCESSES. D. B. Lichtenberg (Stanford Univ., Calif. Stanford Linear Accelerator Center).

The results of using a Regge pole in place of an ordinary pole in Drell calculations of the cross sections for photoproduction of particles were examined. Ratios of the Regge cross sections for π, K, ρ, and $\bar{N}$ production to the ordinary Drell cross section for 6, 18.5, and 25 Mev photons incident on nucleons were calculated. (D.C.W.)

21111 (SLAC-5(p.29-31)) A PROPOSED METHOD TO SEARCH FOR INTERMEDIATE BOSONS AND HEAVY LEPTONS. M. Schwartz (Stanford Univ., Calif. Stanford Linear Accelerator Center).

An arrangement and method for detecting neutrinos arising only from the decay of intermediate bosons and/or heavy leptons is explained. The method could be used to search for leptons with mass higher than the muon mass. (D.C.W.)

21112 (SLAC-5(p.32-9)) KINEMATIC CALCULATIONS TO DETERMINE YIELDS OF PARTICLES ARISING FROM THE DECAYS OF SHORT-LIVED INTERMEDIATE STATES. George Trilling (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Expressions are derived for the yield of a particle produced in the two-body decay of a short-lived intermediate particle. A general solution is obtained and then is generalized to the three-body particle decay. One special case is also treated. (D.C.W.)

21113 (SLAC-5(p.40-78)) THE USE OF HYDROGEN BUBBLE CHAMBERS AT SLAC. George Trilling (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Characteristics required for a hydrogen bubble chamber to be used in the kinematic analysis of individual events in a secondary-particle beam at the accelerator are discussed. Parameters for such a chamber are presented,

and the formulas used in computing angular and momentum errors are examined. Determination of the direction and energy of π^0 from measurements of the decay photon energies and design of a parallel plate array for studying π^0 secondaries of energetic interactions are also explored. (D.C.W.)

21114 (SLAC-5(p.79-89)) SOME CONSIDERATIONS OF BUBBLE CHAMBER EXPERIMENTS WITH M. William Chinowsky (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Aspects of performing bubble chamber experiments at the accelerator on interactions of secondary particles with protons are discussed. Beam intensity, chamber size, detection of secondary processes and neutral pions, and some possible hybrid devices are considered. (D.C.W.)

21115 (SLAC-5(p.90-132)) STRONG INTERACTION PHYSICS WITH SPARK CHAMBERS. M. L. Perl (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Use of spark chambers in secondary strongly interacting beams at the accelerator is discussed. Estimates of expected beam intensities are presented, and rate limitations on trigger electronics and spark chambers are examined. Advantages of a large spark chamber over a hydrogen bubble chamber for certain experiments are given, and utilization of the secondary beam intensity by spark chambers is considered. (D.C.W.)

21116 (SLAC-5(p.133-64)) SPARK CHAMBER DETECTION SYSTEM FOR 3-Bev STORAGE RING. Martin Perl (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Systems for studying events from a 3-Bev electron-positron colliding-beam machine are discussed. Rates of events at various energies are given; and errors in angular, energy, and momentum measurements are determined. Precision necessary in such measurements for event identification is examined, and a large magnetic spark chamber is found acceptable for such work. Several other means of particle identification are discussed, and defects in the proposed device are pointed out. (D.C.W.)

21117 (SLAC-5(p.165-92)) A STORAGE RING FOR 10-Bev MU MESONS. John Tinlot (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Advantages of providing a storage ring for 10-Bev muons at the accelerator are given, and the design of a ring is discussed. Muon-proton scattering experiments are to be performed with the arrangement, and μ-p scattering kinematics at high momentum transfers are examined. (D.C.W.)

21118 (SLAC-5(p.193-221)) μ-BEAMS WITH M AND THEIR APPLICATION TO μ-p ELASTIC SCATTERING EXPERIMENTS. George Masek (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Considerations involved in performing μ-p elastic scattering experiments at the two-mile accelerator are examined. Muon fluxes obtainable before and after necessary pion attenuation are calculated and compared with values for the alternating-gradient synchrotron, the Zero-gradient synchrotron, and the Bevatron. At 15 to 20 Bev muon yields are 10^3 to 10^4 time those of the three other machines. Separation of elastic muon scattering events from kinematically similar inelastic events is considered along with pion contamination of the muon beam. A design of an arrangement for μ-p scattering experiments is presented, and its modification to permit simultaneous neutrino experiments in the end station is discussed. (D.C.W.)

21119 (SLAC-5(p.222-36)) MASS ANALYSIS AT HIGH ENERGY. J. J. Murray (Stanford Univ., Calif. Stanford Linear Accelerator Center).

Electrostatic and r-f mass separation for mass analysis of particle beams is discussed in connection with the two-mile accelerator beams. Separated K meson yields with both techniques are presented. Electrostatic separation seems to be of doubtful use for this application, but r-f separation is concluded to be useful up to and above the maximum energies expected. (D.C.W.)

21120 PARTICLE VELOCITY MEASUREMENTS WITH THE PROTON SYNCHROTRON OF THE C.E.R.N. R. Meunier and J.-P. Stroot (CERN, Geneva). Acta Electronica, 5: 89-101(Jan. 1961). (In French)

Discussion of the methods used to measure the velocity of high-energy particles with a large accelerator reveals the advantages of a certain type of Cherenkov counter. The counter in question and its operating principles are described. The possibilities of this type of counter are illustrated by the results obtained in the analysis of secondary beams in the proton synchrotron of the C.E.R.N. (auth)

21121 CIRCULAR ELECTRON ACCELERATOR WITH TOROIDAL WAVE-GUIDE. J. Ďatlov, V. Boháček, K. Jakubka, R. Klíma, and J. Váňa (Inst. of Vacuum Electronics, Czechoslovak Academy of Sciences, Prague). Czech. J. Phys., 12: 894-910(1962). (In Russian)

A small electron model of a synchrotron with weak focusing and betatron injection was constructed and tested, In it the electrons are accelerated on a radius of 4 cm by a partial traveling wave in a rectangular toroidal resonator, excited in a $E_{1,1,1}$ mode. The source of the h-f power is a tunable impulse magnetron in the 10 BHz band. The possibility of synchronous acceleration of relativistic particles in a smooth toroidal wave-guide in the presence of a strong radial component of the h-f field was thereby confirmed experimentally. (auth)

21122 A 150-kv ION ACCELERATOR. P. Principi (CISE, Milan), T. Rossini, and L. Zetta. Energia Nucl. (Milan), 10: 146-50(Mar. 1963). (In Italian)

A 150-kv accelerator is described. The radiofrequency ion source permits a current of 1 ma to be extracted. The machine can be very conveniently employed as 14 Mev neutron generator through the reaction $H^3(d,n)He^4$ and pulsed as a source of a pulsed neutron beam. (auth)

21123 VAN DE GRAAFF TYPE 300-kev ELECTRON ACCELERATOR FOR EDUCATION PURPOSES. József Bánhalmi and Dénes Bódizs. Mag. Tud. Akad. At. Kut. Int. (Debrecen), Kozlemen., 4: 191-5(Dec. 1962). (In Hungarian)

An apparatus was devised for educational purposes that is capable of accelerating electrons up to an energy of 300 kev. Electron-optical, vacuum-technical, and gamma-dosimetric measurements may be carried out by means of the accelerator. (auth)

21124 ION-OPTICAL BEHAVIOUR OF INCLINED FIELD ACCELERATION TUBES. E. Koltay (Universitet, Copenhagen). Phys. Letters, 4: 66-8(Mar. 15, 1963). (In English)

Results obtained from preliminary calculations concerning the ion-optical behavior of inclined-field acceleration tubes are presented. The considerations are restricted to the meridional plane corresponding to the maximum value for the field inclination angle. (C.E.S.)

21125 THE COMPTON EFFECT ON RELATIVISTIC ELECTRONS AND THE POSSIBILITY OF OBTAINING HIGH ENERGY BEAMS. F. R. Arutyunian and V. A. Tumanian (Physical Inst. of the State Committee of the

Council of Ministers, USSR). Phys. Letters, 4: 176-8 (Apr. 1, 1963). (In English)

When light photons are scattered on extremely relativistic electrons, the energies of the scattered photons are of the same order of magnitude as those of the electrons. The possibility of exploiting this feature for obtaining high energy γ beams in electron accelerators is considered. To obtain γ beams by this method high photon fluxes are required. Ruby lasers are discussed as a high intensity photon source. (C.E.S.)

21126 LINEAR ACCELERATOR OF 15 Mev. T. N. Filimonova and A. M. Shmygov. Zh. Tekhn. Fiz., 32: 1438-45(Dec. 1962). (In Russian)

Descriptions are given of a 15-Mev linear electron accelerator with a 50 ma current. The electron pulse of 0.7 μsec can be reduced to 0.5 μsec. The pulse frequency is 1000 sec, the energy spread is 10%, the total high-frequency energy is 3.5 Mv, and the efficiency is 25%. Two synchronized magnetron generators are used as the high-frequency source. (tr-auth)

21127 SPACE AND TIME DEPENDENCE OF THE SYNCHROTRON MAGNETIC GUIDE FIELD. William Alexander Walker, Jr. Thesis, Charlottesville, Va., Univ. of Virginia, 1962. 237p.

By use of three biased peaking strips, the dynamic magnetic guide field in the University of Virginia 70-Mev synchrotron was measured at 200 locations on the median plane. The measurements were made at three different times corresponding to injection at three typical energies. A coincidence circuit regulated these times within 10^{-8} seconds. At fixed values of φ the results were fitted by the method of least squares to a surface in (r,t). At fixed values of (r,t) the results also were fitted by the same method to a Fourier series truncated at m = 8. The rms deviations of the measured values from the computed values were 1% for the Fourier series and 0.2% for the surface polynomial. The number of captured electrons was computed, and the double beam pulse was discussed in terms of the field structure. (Dissertation Abstr. XXIII, No. 8)

Plasma Physics and Thermonuclear Processes

Refer also to abstract 20217.

21128 (AFOSR-TN-60-779) FORMULAS FOR ESTIMATING WIDTHS OF SPECTRAL LINES EMITTED FROM PLASMAS AND THEIR LIMITS OF VALIDITY. Henry Margenau (Yale Univ., New Haven). [nd]. Contract AF18 (603)-15. 14p. (AD-282887)

Broadening of spectral lines from plasma due to linear and quadratic Stark effects is examined. Areas in which impact and statistical descriptions of the electrons and ions are valid are considered, and half-width formulas for these areas are given. Doppler effect is also treated and is found to determine line widths under certain conditions. (D.C.W.)

21129 (CEA-2224) INFLUENCE DES COLLISIONS SUR LES OSCILLATIONS DANS UN GAZ FAIBLEMENT IONISE. (Influence of Collisions on Oscillations in a Weakly Ionized Gas). P. Bertrand, J. C. Boulassier, and G. Briffod (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 15p.

The influence of electron-molecule collisions on the development of waves in a Lorentzian plasma subjected to a uniform magnetic field is examined. The general dispersion equation is given. The particular case of waves propagated in the direction of the magnetic field is then studied. (auth)

21130 (CEA-2252) UTILISATION D'UN NOUVEAU DETECTEUR D'IONS DANS L'ETUDE DU JET DE PLASMA INJECTE DANS DECA I. (Use of a New Ion-Detector in the Study of the Jet Plasma Injected into DECA I). Claude Renaud (European Atomic Energy Community and France. Commissariat a l'Energie Atomique, Paris). 1963. 41p.

The development of a high-sensitivity ion detector coupled to an electrostatic analyzer permitted an investigation of the plasma jet injected into a pulsed magnetic mirror configuration. In this detector the positive ions are accelerated through a potential of 30 kv; they strike a metallic target, on which they produce secondary electrons; these, in turn, are accelerated onto a plastic scintillator. The light pulses are detected with a photomultiplier. The gain of this device is about 10^7. If air is admitted into the vacuum system, then re-evacuated, the gain is not modified since no special activated surfaces are situated in the detector. (auth)

21131 (CLM-R-27) REFRACTION OF MICROWAVES BY A PLASMA CYLINDER. D. J. H. Wort (United Kingdom Atomic Energy Authority. Research Group. Culham Lab., Culham, Abingdon, Berks, England). Jan. 1963. 17p.

The analysis of a nonuniform plasma by microwave or infrared transmission requires some knowledge of the refraction of the probing beam by a medium whose refractive index varies continuously. The ray optics of such a beam traversing a cylinder of plasma whose density profile is parabolic, the plane of incidence of the beam being normal to the cylinder axis, are examined. Calculations of phase shift and attenuation are presented in a form suitable for experimental application, and sample ray trajectories are given. All diffraction effects are ignored, but the validity of ray optics is examined. (auth)

21132 (HE-150-209) A SYNCHRONOUS CONVERTER POWERED PLASMA GENERATOR SYSTEM (thesis). Robert Eugene Clough (California. Univ., Berkeley. Inst. of Engineering Research). Jan. 25, 1963. For Univ. of California, Lawrence Radiation Lab., Livermore). Contract [W-7405-eng-48]. 50p. (UCRL-13079)

A plasma generation system powered by a synchronous converter power supply was designed and constructed. Two separate plasma generator models, designed as the tip-tube unit and the tube-tube unit, were developed and operated satisfactorily. The necessary supporting equipment, comprising the electrical power, cooling water, plasma gas, and magnet subsystems, was designed and fabricated for use up to a power level of one megawatt. The power utilized by the two plasma generators during the performance investigations was in the 75 to 125 kw range. The enthalpy and temperature of the resulting plasma stream was estimated to be 2500 to 4500 Btu/lb and 6000 to 9000°R, respectively. Analysis of these results and consideration of the capabilities of the system indicates that it is possible to obtain ranges of plasma stream enthalpy and temperature of 1000 to 8500 Btu/lb and 4000 to 11,500°R, respectively. The most satisfactory operation was obtained with the tip-tube unit. However, with modification of the anode of the tube-tube unit equally successful operation is anticipated. 23 references. (auth)

21133 (IPPJ-4) LANGMUIR PROBE METHOD FOR A PLASMA HAVING SMALL AMPLITUDE OSCILLATIONS. Minoru Sugawara and Yoshisuke Hatta (Nagoya, Japan. Univ. Inst. of Plasma Physics). Feb. 1963. 23p.

Langmuir probe characteristics for a plasma having oscillations of space potential, electron density and electron temperature are discussed in detail. A method for deriving amplitudes of oscillation as well as values of their d.c. components is introduced. In order to get information about oscillating components, the "method of constant current probe" developed by Barnes and Eros is applied with some extension. Probe characteristics showing the effects of various oscillations are displayed. (auth)

21134 (MATT-143) ON THE STABILITY OF HYDROMAGNETIC SYSTEMS WITH DISSIPATION. Bruno Coppi (Princeton Univ., N. J. Plasma Physics Lab.). Jan. 1963. Contract AT(30-1)-1238. 38p.

The effects of electrical resistivity, viscosity, and thermal conductivity on the stability of a hydromagnetic system are examined. A motion equation governing small displacements about the equilibrium and the associated quadratic form which replaces the energy principle are derived. Proper expressions for these equations are deduced by using different expansion techniques, in order to obtain information about the influence of the various dissipative parameters on modes which are stable, marginally stable, or singular in their absence. The fastest growth rates are evaluated and the main features of the possible instabilities are deduced in general. Agreement is found with the calculations carried out for some special models of physical interest by different authors. (auth)

21135 (MATT-164) PHENOMENA IN RUNAWAY DOMINATED STELLARATOR DISCHARGES. Wolfgang Stodiek and Don J. Grove (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1962. Contract AT(30-1)-1238. 11p.

Further experiments were performed with the Model C Stellarator to study the current steps produced by runaway electron absorption and by loss to the walls. Initial current increases were noted in examination of the absorption type step and were explained by an increase of relativistic electrons. The results for absorption type steps support a model involving an electron-electron two stream instability. No single theory has been developed for loss type current steps showing copious x rays. (D.C.W.)

21136 (MATT-168) CESIUM PLASMA EXPERIMENTS. Nathan Rynn (Princeton Univ., N. J. Plasma Physics Lab.). Dec. 1962. Contract AT(30-1)-1238. 29p.

Design and operation of the Q-machine is discussed, and experiments performed with it are examined. Diffusion experiments were performed by injecting the vapor from a heated calcium-alkali chloride mixture into the device. An order of magnitude agreement was obtained with classical, $1/B^2$, diffusion theory; and disagreement by two or three orders of magnitude with Bohm, 1/B, diffusion was noted. Passage of current through the plasma resulted in I-V characteristics that were grossly symmetric. Large amplitude oscillations started just beyond the current maximum, and the initially peaked density distribution flattened out as current increased. A tentative hypothesis for the onset of instability, based upon electron runaway, was advanced. Diffusion after the onset of instabilities was also examined, and the effect of assuming 1/B diffusion was investigated. Diffusion coefficients for Bohm and classical diffusion were calculated and compared with values determined from data. The 1/B values agreed within one order of magnitude while the classical values disagreed by three orders of magnitude. (D.C.W.)

21137 (NBS-7677) THIRTEENTH PROGRESS REPORT ON THE CRYOGENIC ASPECTS OF PROJECT SHERWOOD, DECEMBER 31, 1962 TO MARCH 31, 1963. (National Bureau of Standards. Boulder Labs., Boulder, Colo.). Mar. 31, 1963. 5p.

Investigation revealed the magnetic properties of cold-drawn niobium to be unexpectedly isotropic. Using the Ginzburg-Landau theory, Shapoval predicted a temperature dependence of the critical field that is greater than that observed on hard superconductors. The charging supply for the pulsed-field capacitor bank was tested successfully, and one of the copper-foil wound pulse magnets failed with a small pulse. The high vacuum deposition system was improved, and a superconducting Helmholtz pair to give a field uniform to 0.1% over a ½-inch diameter sphere was designed. No experimental work was done on the aluminum magnet, but two papers on it were published. Basic refrigeration cycle analysis work involved changes in the computer program for each basic cycle and a revision of neon thermodynamic properties. Redesigned gas-lubricated bearings to match the low-pressure turbine system were tested successfully. Turbine rotor changes had little effect on the 63% expander efficiency. (D.C.W.)

21138 (NP-12154(Rev.)) ELECTROSTATIC ACCELERATION OF NEUTRAL PLASMAS—MOMENTUM TRANSFER THROUGH MAGNETIC FIELDS. Research Report 150. G. S. Janes, J. Dotson, and T. Wilson (Avco Corp. Avco-Everett Research Lab., Everett, Mass.). Sept. 1962. Contract AF49(638)-659. 26p.

Supersedes AMP-88.

Electrostatic plasma accelerators for accelerating neutral plasmas are discussed. Energy input is produced by an electrostatic field applied parallel to the direction of plasma acceleration, while momentum input is produced by an applied magnetic field with components perpendicular to the direction of acceleration. Such accelerators avoid the space-charge limitations of conventional ion rockets and impose only moderate requirements on magnetic field strength and on power level. Theory is discussed, and experiments that substantiate the mechanism for momentum transfer to neutron plasmas are described. The experiments agree approximately with the anomalous (Bohm type) diffusion model and disagree clearly with the classical model. Significance of this result and ways for dealing with it are considered. (auth)

21139 (NP-12712) ANNUAL REVIEW [OF RESEARCH] APRIL 1961–MARCH 1963. (Nagoya, Japan. Univ. Inst. of Plasma Physics). Mar. 31, 1963. 53p.

The status of the QP high-temperature-plasma device is reported. Design of the device is discussed, and preliminary tests performed on its components are described. Experimental work involved research on plasma production by the cesium plasma tube, the quiescent discharge tube, the hollow-magnetic-field discharge tube, the low density plasma tube, and the electron beam plasma tube. Results of some studies on these plasmas are given. Development of probes, spectroscopes, resonance probes, and microwave interferometers for plasma diagnostics is also discussed. Research on oscillations in plasma, on plasma beams in magnetic fields, and on beam-plasma interactions in a magnetic field was also performed. Theoretical work on the structure of a fresh plasma surface and on radiation processes by plasma waves in a homogeneous plasma with no magnetic field is summarized. (D.C.W.)

21140 (ORNL-3161) ENERGY DISTRIBUTION OF IONS AND ELECTRONS IN DCX AFTER BURNOUT: ORACLE CODE EDDIE. T. K. Fowler and M. Rankin (Oak Ridge National Lab., Tenn.). Sept. 13, 1961. Contract W-7405-eng-26. 32p.

Numerical calculations of energy distributions of ions and electrons in DCX in steady state after burnout are discussed. The d-c plasma potential establishing quasi-neutrality is also determined. The electron distribution is found to be Maxwellian, but the ion distribution is not. For typical DCX conditions, the plasma potential is an appreciable fraction of the injected ion energy (tens of kev). The code employed, ORACLE code EDDIE, which solves coupled, steady-state Fokker-Planck equations governing the ion and electron distributions in energy space, is discussed. (auth)

21141 (TID-18503) THERMONUCLEAR PLASMA STUDIES. Quarterly Status Report No. 1. (Wisconsin. Univ., Madison). Apr. 15, 1963. Contract AT(11-1)-1233. 6p.

An 80-liter differential pumping chamber through which plasma passes from the gun to the multipole structure was completed and operated with a conical pinch plasma gun. Gas pressure distribution was examined, and a fast shutter to keep neutral gas from passing through the chamber into the multipole was tested. Probe tests of the conical pinch gun when driven by a low inductance system yielded plasma speeds of 1.5×10^7 cm/sec. The theoretical program for multipole calculation gave structure shapes for multipoles. Tests indicated that the limiting stable line of force is not changed appreciably when a mechanically realizable approximation to ideal geometry is used. An expression for the last stable flux line was obtained by digital computation. (D.C.W.)

21142 (UCRL-6631) SINGLE-STREAMING AND CONTRA-STREAMING INSTABILITIES IN A RESISTIVE BACKGROUND. Charles K. Birdsall (California. Univ., Livermore. Lawrence Radiation Lab.). May 24, 1962. Contract W-7405-eng-48. 41p.

The growth rate obtained for a model of opposing electron or ion streams is altered by the presence of a resistive background, as provided by collisions in a neutralizing background. Temporal growth, obtained with double streaming alone at long wavelengths, tends to become single-streaming growth with distance along each stream as the conductivity of the background is raised, with the largest growth rate moving to shorter wavelengths. The resistive background damps the double-streaming instability by reducing its rate of growth and shifting its maximum growth to longer wavelengths, but also introduces a new growth mechanism, with comparable growth rate, at shorter wavelengths. The physical basis for the temporal or distance growth of a disturbance on a single stream in a resistive background comes from elementary considerations or from the existence of the negative a-c kinetic energy on the slower space-charge wave of the stream. The experimental verification of this mechanism is given for growth with distance, that is, for an amplifier. (auth)

21143 LONGITUDINAL WAVES IN AN INHOMOGENEOUS MAGNETIC FIELD-PLASMA INTERFACE BASED ON THE WKB APPROXIMATION. I. P. Shkarofsky (RCA Victor Research Labs., Montreal). Can. J. Phys., 41: 569-80 (Apr. 1963).

Longitudinal perturbations are investigated which propagate in an inhomogeneous interface or transition boundary layer, from a plasma region where no magnetic field exists well within its interior, to a static magnetic field region from which the plasma is excluded. The inhomogeneity in this boundary layer is the prime inhomogeneity considered here. A WKB solution is obtained for waves whose wavelength is small compared with the equilibrium characteristic length. The component of the propagation wave number is assumed to vary in the direction in which the interface is inhomogeneous. From the zero-order solution it is shown that this wave number satisfies the same relation with the frequency of perturbation and velocities of the electron and ion beams, as that obtained in counter-streaming of an electron-plus-ion beam against another electron-plus-ion beam in a uniform medium. The first-order solution yields the manner in which the amplitude of the wave varies from point to point in the plasma interface. The physical significance of these modes and the time and space variation of these waves are discussed. It is shown that the WKB solution is valid in the sheath up to quite small distances from the sheath boundary. Under certain conditions, a wave can exist which increases exponentially in time and whose amplitude increases towards the boundary. The problem of joining the WKB solution appropriately to a perturbed solution outside of the boundary is discussed. (auth)

21144 PROSPECTS FOR RESEARCH ON NUCLEAR FUSION. Jiri-George Linhart (Euratom-CNEN, Rome). Comit. Naz. Energia Nucl., Notiziario, 9: No. 2, 39-43 (Feb. 1963). (In Italian)

The present research on nuclear fusion is reviewed with special reference to studies on continuous-operating and pulsed reactors. (auth)

21145 EXPERIMENTAL VERIFICATION OF THE HEATING OF PLASMA BY PROPAGATION OF RIGHT CIRCULARLY POLARIZED WAVES. Terenzio Consoli, Georges Ichtchenko, and Micheline Weill. Compt. Rend., 256: 1090-2(Jan. 28, 1963). (In French)

The heating effect of an attenuated plasma crossed by a right circularly polarized wave was described and interpretated. The heating is manifested by a propagation discontinuity and the displacement and variation of length of the resonance ray. The effects were previously studied theoretically. (tr-auth)

21146 NECESSARY AND SUFFICIENT CRITERIA FOR STABILITY OF A LOW PRESSURE PLASMA WITHOUT MAGNETIC SURFACES. Jean Andreoletti (CEN, Saclay, France). Compt. Rend., 256: 1469-72(Feb. 11, 1963). (In French)

From variational energy principles relative to the equilibrium and stability of a hot plasma in a strong magnetic field, there is derived, to the first order in β, a constraint on the pressure tensor as well as necessary and sufficient stability criteria for low pressure configurations without magnetic surfaces. (tr-auth)

21147 VARIATIONAL SOLUTION OF PLASMA RESONANCES. ESTABLISHMENT OF THE PRINCIPLE AND APPLICATION TO A PLANE SYSTEM. Frédéric Crawford and Gordon S. Kino (CEN, Saclay, France and Stanford Univ., Calif.). Compt. Rend., 256: 1939-41(Feb. 25, 1963). (In French)

Since the effective permittivity of a plasma can be negative, resonances can be produced in the presence of dielectrics and conductors. The resonance frequencies are easily given in the case of a uniform plasma by solution of the Laplace equation. A variational principle is established which permits solutions to be obtained in the case of a non-uniform density without precise knowledge of the distribution of the electric field in the plasma. The solution is given for a plane system. (tr-auth)

21148 COMPUTER SOLUTION OF THE PROBLEM OF INTERACTING CHARGED PARTICLES OF THE SAME SIGN IN A "MAGNETIC BOTTLE". S. P. Lomnev (Computer Center, Academy of Sciences, USSR). Dokl. Akad. Nauk SSSR, 148: 1049-52(Feb. 11, 1963). (In Russian)

Solution of problems presented by the motion of a large number of interacting particles by means of a series of corresponding equations is often preferable to operations involving the use of the kinetic Boltzmann equation because of the possibility of taking the actual particle-injection conditions and the space occupied by the external electric and magnetic field into account. Such a problem, the calculation of the motion of combined charged particles interacting in a "magnetic bottle" type system, was investigated mathematically. The conditions considered included continuous injection of particles at a given initial distribution. The solution obtained on the computer showed that the longitudinal motion of the particles in the center of the system leads to the broadening of the beam in the transverse direction, resulting in its partial loss on the walls; compression of the particles by the field in the region of the "magnetic stopper" causes their passage through the stopper, thus causing further losses. The energy distribution was found to be non-Maxwellian. (TTT)

21149 NUCLEAR FUSION— TO-MORROW'S SOURCE OF ENERGY. L. Rothhardt (Deutschen Akademie der Wissenschaften, Jena, Ger.). Energietechnik, 12: 492-5 (Nov. 1962). (In German)

The means for producing nuclear fusion with the problems associated with it are explained. The present state of development of research is reported and a view of the possibility of energy production from nuclear fusion is given. (tr-auth)

21150 RESONANT EFFECT OF PLASMA WAVES ON CHARGED PARTICLES IN A MAGNETIC FIELD. J. W. Dungey (Atomic Weapons Research Establishment, Aldermaston, Berks, Eng.). J. Fluid Mechan., 15: 74-82(Jan. 1963).

Resonances are discussed between electrons and protons and waves of whistler and hydromagnetic types. The conditions of resonance are investigated. Approximations for the effects on the particles are obtained. The occurrence of a "trapping" phenomenon is demonstrated and the effect on velocity distributions is discussed. (auth)

21151 NONLINEAR SPACE CHARGE EFFECTS IN COLD PLASMA. Tosiya Taniuti (Kobe Univ., Japan). J. Phys. Soc. Japan, 18: 408-19(Mar. 1963). (In English)

The following nonlinear effects in one-dimensional motion of a cold plasma are discussed: the nonlinear space charge wave due to a modulation of electron velocity at one end of a tube filled with plasma; the effect of ion motion on the fine scale mixing (the orbit crossing). The effect of magnetic field is also discussed in a special case. (auth)

21152 ELECTRON TEMPERATURE OF HELIUM PLASMAS PRODUCED BY THETA PINCH. Masahiro Yokota (Nihon Univ., Tokyo). J. Phys. Soc. Japan, 18: 419-26(Mar. 1963). (In English)

The electron temperatures of the plasmas produced by the theta pinch with $dB/dt = 8 \times 10^8$ gauss/sec were measured spectroscopically by two different methods, one using the intensity ratio of HeI (4921Å) to HeII (4686Å), and the other using those of singlet lines (4921Å, 4387Å) to triplet line (4713Å). The pairs of spectral line intensities were measured simultaneously by two photomultipliers. The temperatures obtained are 6 ev in the former case and 40 ev in the latter. The electron density determined from Stark broadening of 4686Å is $3.5 \times 10^{15}/cm^3$. The large discrepany between these electron temperatures is due to the radial inhomogeneity of plasmas and due to some decaying mechanism of charged particles more rapid than the two-body recombination. Thus, the method using ionic lines gives erroneously lower temperatures and the temperatures obtained from neutral pairs are more reliable. (auth)

21153 MICROWAVE STUDY OF PLASMAS PRODUCED BY ELECTROMAGNETICALLY DRIVEN SHOCK WAVES. Susumu Takeda and Takashige Tsukishima (Nagoya Univ., Japan). J. Phys. Soc. Japan, 18: 426-37(Mar. 1963). (In English)

A microwave reflection method is applied to the measurement of very high electron densities in plasmas produced by shock waves. The electron density can be determined from the phase angle of a reflection coefficient at the sharp boundary of the plasma that exists at the end of the shock tube. The electron densities measured by an X-band frequency (9000 Mc) range from 10^{13} to 10^{15} cm^{-3}. The plasma is produced by shock waves of Mach number 8 to 15 in argon at a pressure of 0.1 mm Hg. The electron densities are compared with values predicted by theoretical calculations under thermal equilibrium. The maximum density detectable reaches 1×10^{16} cm^{-3}. The afterglow plasma which continues after the shock wave has passed is investigated. The loss mechanism of electrons during a few hundred microsecor is seems not to depend on diffusion but on recombination. The temperature of electrons which are almost in thermal equilibrium with ions and neutral atoms in this afterglow plasma is sustained for a relatively long time. (auth)

21154 THE CONSERVATION EQUATIONS OF A CLASSICAL PLASMA IN THE PRESENCE OF RADIATION. R. Simon (Purdue Univ., Lafayette, Ind.). J. Quant. Spectry. Radiative Transfer, 3: 1-14(Jan.-Mar. 1963).

The conservation equations of a plasma are derived, taking into account the presence of radiation. Although the plasma is considered in the framework of classical gas dynamics, radiation is described as a relativistic photon gas. The 4 energy-momentum tensor of this gas is decomposed according to a process already used by Eckart in the case of a relativistic gas of material particles. The case of local thermodynamic equilibrium is also considered. (auth)

21155 OPTICALLY THICK PLASMAS. Richard H. Tourin (Warner and Swasey Co., Flushing, N. Y.). J. Quant. Spectry. Radiative Transfer, 3: 89-90(Jan.-Mar. 1963).

Experimental evidence is presented to show that plasmas are often optically thick. Data are included on the absorption and emission spectra of Ar and N plasmas produced in a plasmajet torch. These plasmas were found to be optically thin only at wavelengths shorter than 0.65 μ. (J.R.D.)

21156 A CONTRIBUTION TO THE KINETIC THEORY OF RAREFIED GASES IN A MAGNETIC FIELD. S. S. Moiseev. Nauchn. Zap. Poltavsk. Inst. Inzh. Sel'skokhoz. Stroit., 7: 91-104(1961).

Equations for the viscosity tensor and thermal flux of a system of charged particles in the presence of a magnetic field were derived from Boltzmann equations. It was assumed that deviations from the local Maxwellian distribution (with macrovelocity parallel to the magnetic field) were sufficiently small, and that the distribution functions could be described fully by the usual thirteen moments. Particular examples of the solution of equations describing the behavior of viscosity tensor and thermal flux are considered. If initial conditions are such that there are no macromotions of the gas, density and pressure are constant, and the viscosity tensor and thermal flux are only time-dependent, then the solution of the relevant equations shows that the viscosity tensor components oscillate with a frequency being a multiple of the Larmor frequency and are damped simultaneously. The possibility of a steady

thermal flux in the presence of a magnetic field was also investigated. Moreover, the case of two types of charged particles is considered, neglecting the disturbance of ion distribution. (Referativnyy zhurnal, Fizika, No. 10, 1962)

21157 PROPAGATION OF A DOUBLE-STREAM INSTABILITY IN A PLASMA. M. Feix (General Atomic Div., General Dynamics Corp., San Diego, Calif.). Nuovo Cimento (10), 27: 1130-7(Mar. 1, 1963). (GA-3393). (In English)

The problem of the propagation of a perturbation initially localized is considered in the case of an unstable plasma. A linearized theory (which puts a time limitation for the validity of the theory) and a one-dimensional geometry are used. It is found that the front of the instability propagates with a velocity v_0, but that the main part of the energy diffuses slowly, i.e., is localized in a zone whose dimension increases as $\sqrt{t}$. (auth)

21158 FINITE-RESISTIVITY INSTABILITIES OF A SHEET PINCH. Harold P. Furth (Univ. of California, Livermore), John Killeen, and Marshall N. Rosenbluth. Phys. Fluids, 6: 459-84(Apr. 1963).

The stability of a plane current layer is analyzed in the hydromagnetic approximation, allowing for finite isotropic resistivity. The effect of a small layer curvature is simulated by a gravitational field. In an incompressible fluid, there can be three basic types of "resistive" instability: a long-wave tearing mode, corresponding to breakup of the layer along current-flow lines; a short-wave rippling mode, due to the flow of current across the resistivity gradients of the layer; and a low-g gravitational interchange mode that grows in spite of finite magnetic shear. The time scale is set by the resistive diffusion time τ_R and the hydromagnetic transit time τ_H of the layer. For large $S = \tau_R/\tau_H$, the growth rate of the tearing and rippling modes is of order $\tau_R^{-\frac{1}{2}} \tau_H^{-\frac{1}{2}}$, and that of the gravitational mode is of order $\tau_R^{-\frac{1}{3}} \tau_H^{-\frac{2}{3}}$. As $S \to \infty$, the gravitational effect dominates and may be used to stabilize the two nongravitational modes. If the zero-order configuration is in equilibrium, there are no overstable modes in the incompressible case. Allowance for plasma compressibility somewhat modifies the rippling and gravitational modes, and may permit overstable modes to appear. The existence of overstable modes depends also on increasingly large zero-order resistivity gradients as $S \to \infty$. The three unstable modes merely require increasingly large gradients of the first-order fluid velocity; but even so, the hydromagnetic approximation breaks down as $S \to \infty$. Allowance for isotropic viscosity increases the effective mass density of the fluid, and the growth rates of the tearing and rippling modes then scale as $\tau_R^{-\frac{1}{2}} \tau_H^{-\frac{1}{2}}$. In plasmas, allowance for thermal conductivity suppresses the rippling mode at moderately high values of S. The tearing mode can be stabilized by conducting walls. The transition from the low-g resistive gravitational mode to the familiar high-g infinite conductivity mode is examined. The extension of the stability analysis to cylindrical geometry is discussed. The relevance of the theory to the results of various plasma experiments is pointed out. A nonhydromagnetic treatment will be needed to achieve rigorous correspondence to the experimental conditions. (auth)

21159 GREEN'S FUNCTION FOR THE LINEARIZED ONE-DIMENSIONAL KROOK EQUATION WITH ELECTRIC FORCES. Harold Weitzner (New York Univ., New York). Phys. Fluids, 6: 484-90(Apr. 1963).

An integral representation is obtained for the Green's function for the linearized one-dimensional Krook equation with the induced electric field of the medium included. Various asymptotic expansions in time are then obtained. When the plasma frequency is set to zero, slightly modified hydrodynamic modes appear. For nonzero plasma frequency only plasma oscillations unaffected by the collisions are present. Finally, the initial value problem corresponding to an initial wave packet of approximate wavenumber k is considered. For times long, but not too long, plasma oscillations are present for which the frequency and wavenumber satisfy the usual Landau dispersion relation for small wave-number. After a sufficiently long time, the solution behaves like the Green's function itself and exhibits Landau damping. (auth)

21160 FIRST- AND SECOND-ORDER PERTURBATIONS OF PLASMAS WITH CAUCHY EQUILIBRIUM DISTRIBUTIONS. H. B. Liemohn (Boeing Scientific Research Labs., Seattle) and F. L. Scarf. Phys. Fluids, 6: 490-500 (Apr. 1963).

The space-time behavior of initial density perturbations (acoustic mode) in hot plasmas is analyzed, including second-order effects, using a one-dimensional Cauchy velocity distribution of the form $(v^2 + a^2)^{-2}$ for the equilibrium distribution. The initial density perturbation is assumed to be sinusoidal in space and to have the same Cauchy velocity distribution. The first-order solution has an exact analytic form that gives damped oscillations at a thermally shifted plasma frequency. The nonlinear interference between the density wave and its electric field produces second harmonics in both space and time that appear in the analytic second-order solution. The harmonic structure suggests a spectral decay of the initial perturbation energy. In general, the oscillation frequency and damping decrement increase with temperature so that at sufficiently high temperatures, all forms of ordered motion are destroyed by the random thermal motion. (auth)

21161 PLASMA RESONANCE INTERACTION WITH A SPATIALLY ROTATING STATIC MAGNETIC FIELD. H. Karr, E. Knapp, and W. Riesenfeld (Los Alamos Scientific Lab., N. Mex.). Phys. Fluids, 6: 501-7(Apr. 1963). (LADC-5510)

The ion cyclotron resonance interaction of plasma with a rotating transverse magnetic perturbation on a longitudinal magnetic field is investigated experimentally and theoretically. The plasma is injected axially from a coaxial hydromagnetic gun along a longitudinal magnetic field on which there is superimposed a transverse spatially rotating perturbation field. A resonance transfer of ion energy from the longitudinal to the transverse direction is observed when the spatial period or wavelength of the perturbation field and the plasma velocity and ion cyclotron frequency satisfy the relation $\lambda_z = 2\pi v_z/\Omega_B$. Measurements of plasma diamagnetism and transit time show an increase of up to a factor of two in diamagnetism coupled with a decrease in axial velocity corresponding to a reduction to half the initial longitudinal energy. Resonance may be observed over a range of longitudinal energies by varying the parameters of the system. For the plasma gun and perturbation field helix used in the experiment, optimum resonance was obtained with plasmas of longitudinal energy of ~ 2.5 kev and particle densities of $\sim 10^{13}$ cm^{-3} ($\beta \gtrsim 0.8$). A theoretical account of the effect is given that considers the excitation by the perturbation field of circularly polarized electromagnetic waves in the plasma at ion cyclotron frequency and the transfer of longitudinal ion energy into transverse motion through the intermediate action of the waves. (auth)

21162 THERMAL IONIZATION IN A SYSTEM WITH A DISTRIBUTION OF IONIZATION POTENTIALS. A. Mait-

land and M. H. Dunn (International Research and Development Co. Ltd., Newcastle upon-Tyne, Eng.). Phys. Fluids, 6: 586-9(Apr. 1963).

In a hydrogen plasma, the microfields act upon the neutral atoms and cause Stark effects that result in a distribution of ionization potentials. The distribution function is derived and used with the Saha equation to calculate the electron densities that are then compared with those calculated from a single ionization potential derived from an average microfield given by $Cen_e^{\frac{2}{3}}$ where C = 4.2, 3.7, and 2.6, respectively, depending on the method of averaging. The temperature range considered is 5750 to 10,700°K in which the electron densities are between 10^{14} and 10^{17} cm^{-3} when the neutral particle densities are 10^{17}–10^{19} cm^{-3}. Within these ranges, whereas the electron density calculated from a single ionization potential based on an average field is up to about 1% greater than that given by the Saha equation using the ionization potential of an isolated atom, calculation using the distribution equation gives values up to about 2% greater. (auth)

21163 ION WAVES IN AN INHOMOGENEOUS PLASMA. N. D'Angelo (Princeton Univ., N. J.). Phys. Fluids, 6: 592-3(Apr. 1963). (MATT-147)

Low-frequency ion waves that might be present as a result of a macroscopic ion flux perpendicular to the magnetic lines of force are considered for a plasma of low ratio of material to magnetic pressure, with a density gradient at right angles to a constant and uniform magnetic field. The analysis is based on the Boltzmann moment equations for the ions and electrons. (C.E.S.)

21164 DYNAMIC COUPLING OF MEDIUM MICROWAVE POWER WITH SHOCK-PRODUCED PLASMAS. G. W. Bethke and A. D. Ruess (General Electric Space Tech. Center, King of Prussia, Penna.). Phys. Fluids, 6: 593-4(Apr. 1963).

The results of preliminary microwave-shock produced plasma interaction experiments at microwave power levels that are sufficient to alter the plasma are reported. A 2-in. ID shock tube is used to produce helium-driven xenon and krypton plasmas at initial temperatures of 7,000–12,000°K and heavy particle densities of ~10^{17} cm^{-3}. The microwave coupling experiments were applied to shocks of ~Mach 9 in 1.0 mm Hg of krypton. Shock front electron density profiles both with and without the application of r-f power are shown. (C.E.S.)

21165 DYNAMIC COUPLING OF HIGH MICROWAVE POWER WITH SHOCK-PRODUCED PLASMAS. G. W. Bethke, E. D. Frohman, and A. D. Ruess (General Electric Space Tech. Center, King of Prussia, Penna.). Phys. Fluids, 6: 594-6(Apr. 1963).

Preliminary microwave-shock-produced plasma interaction experiments at high microwave power levels are reported that can result in the formation of a second plasma. A circular 2-in. ID shock tube waveguide is used to produce helium driven xenon and krypton plasmas at initial temperatures of 7,000–12,000°K and densities of ~10^{17} cm^{-3}. The onrushing shock-produced plasma is axially irradiated with X band microwaves (8.35 kMc/sec). The experiments described are for Mach 9 shocks in 1.0 mm Hg of xenon and krypton. When the irradiating X band microwave power is above some critical value for any given plasma, an r-f generated plasma detaches from the shock front and rapidly proceeds down the tube toward the r-f source, shielding the shock front from further irradiation. (C.E.S.)

21166 ADIABATIC COMPRESSION OF PLASMA BY A CYLINDRICAL MULTIPOLAR CUSP MAGNETIC FIELD. Koji Uo (Princeton Univ., N. J.). Phys. Fluids, 6: 596-7 (Apr. 1963).

The magnetic field produced by positive and negative pairs of straight line currents placed in a cylindrical configuration creates a magnetic bottle. After a pure plasma is produced inside the magnetic field configuration the current in the coils is increased to adiabatically compress the plasma by the magnetic barrier produced. A pure, highly compressed plasma is obtained with no trapped magnetic field inside. To avoid end losses the current carrying conductors creating the multipolar field must be brought together at the tube end in a configuration similar to the lines of force in a mirror machine. This cylindrical multipolar cusp magnetic field should be useful in ion cyclotron plasma heating experiments to keep the hot plasma away from the wall and thus reduce the impurity levels. (C.E.S.)

21167 HOT-ELECTRON PLASMA BY BEAM-PLASMA INTERACTION. I. Alexeff (Oak Ridge National Lab., Tenn.), R. V. Neidigh, W. F. Peed, E. D. Shipley, and E. G. Harris. Phys. Rev. Letters, 10: 273-6(Apr. 1, 1963).

A 5-kev d-c electron beam interacting with a plasma of deuterium yielded x-ray photons with energies up to 250 kev from the plasma region. An electron temperature of 32 kev and an electron density of $4 \times 10^{?}$ electrons cm^{-3} are inferred from the total photon flux and its energy distribution. The plasma existed in the steady state and was contained in a magnetic mirror system with the electron stream on the axis. A 3 to 1 mirror ratio was used with a 1500 gauss field at the midplane. (C.E.S.)

21168 RESISTIVITY IN A FULLY IONIZED GAS. S. K. Kundu (Australian National Univ., Canberra). Proc. Phys. Soc. (London), 81: 233-9(Feb. 1, 1963).

A simple method of calculating the resistivity in a fully ionized gas is discussed. In the presence of an electric field the electron velocities have a shifted Maxwellian distribution, shifted by the amount v_d, the drift velocity, and in the case of a magnetic field an anisotropy in the velocity distribution is assumed. It is shown that the present estimate of the resistivity agrees fairly well with that obtained by Spitzer and others. A relation between the electron thermal velocities parallel and perpendicular to the externally applied magnetic field is also suggested. (auth)

21169 PRESSURE DEPENDENT CHARACTERISTICS OF THE Z PINCH IN ARGON AND NITROGEN. F. L. Curzon, R. J. Churchill, and R. Howard (Univ. of British Columbia, Vancouver). Proc. Phys. Soc. (London), 81: 349-55(Feb. 1, 1963).

A framing camera was used to study the initial collapse of the linear Z pinch in argon and nitrogen over a pressure range of 25 to 750 μmHg. A comparison of the computed and observed dynamics of the discharge column reveals the existence of a delayed collapse at the higher pressures, that is interpreted in terms of the breakdown characteristics of gas left near the walls of the discharge vessel during the early stages of the discharge. At the lower pressures the snow-plow model is found to be a good representation of the dynamics of the discharge in both gases in spite of the streamers observed in the nitrogen discharge columns. (auth)

21170 NON-LINEAR INTERACTION OF OPPOSITELY PROPAGATING ELECTROMAGNETIC WAVES AT A PLASMA-FREE SPACE INTERFACE. M. S. Sodha and C. J. Palumbo (Republic Aviation Corp., Framingdale, N. Y.). Proc. Phys. Soc. (London), 81: 473-7(Mar. 1, 1963).

The non-linear interaction of oppositely propagating

electromagnetic waves at a plasma-free space interface was investigated by means of second-order solutions of the Boltzmann kinetic equation and the wave equation. An interesting result of the analysis is the fact that the reflected component of the wave incident from the freespace side has a portion that carries the modulations imposed on the other wave. (auth)

21171 THE SCATTERING OF A PLANE WAVE BY A BOUNDED PLASMA. G. H. Bryant and R. N. Franklin (Royal Military Coll. of Science, Shrivenham, Wilts, Eng.). Proc. Phys. Soc. (London), 81: 531-43(Mar. 1, 1963).

The scattering of a plane electromagnetic wave by a bounded column of plasma was calculated treating the plasma as a dielectric medium small in diameter compared with the incident wavelength. Results are given for the dependence of position and width of the resonance found, taking into account glass walls and collisions of the electrons. The theory is developed to apply when the column is placed across a rectangular waveguide propagating the fundamental transverse electric mode. Comparison is made with experimental measurements and the relevance to the subsidiary resonances observed experimentally is examined. (auth)

21172 APPLICATION OF A NEW METHOD OF CALCULATING CURRENTS IN THE IONIC CENTRIFUGE. J. Slepian. Proc. Phys. Soc. (London), 81: 587-9(Mar. 1, 1963).

A method for calculating the current taken by the end plates and cylinder in a plasma discharge is applied to the ionic centrifuge. (C.E.S.)

21173 INFRARED DIVERGENCIES IN STATISTICAL MECHANICS OF ELECTRON PLASMA. Keiji Watanabe (Tokyo Univ.). Progr. Theoret. Phys., (Kyoto), 28: 951-8 (Dec. 1962). (In English)

The problem of infrared divergencies that appear in the perturbation series in quantum statistical mechanics of electron gas is discussed generally. It is shown that no infrared divergency appears in the exact partition function. The suppression of infrared divergency is connected with the existence of plasma oscillation. The dispersion relation of the plasma oscillation is obtained as a pole of the time dependent Green function. (auth)

21174 ON THE BOHM DIFFUSION COEFFICIENT. S. S. Moiseev and R. Z. Sagdeev (Novosibirsk State Univ., USSR). Zh. Eksperim. i Teor. Fiz., 44: 763-5(Feb. 1963). (In Russian)

In 1949 D. Bohm observed that the coefficient for plasma diffusion across magnetic lines exceeded that of the classical kinetic theory. The anomalous phenomenon was explained by an unknown instability inducing transition plasma turbulence. The coefficient of anomalous diffusion was postulated to be $D_\perp = cT/16eH$, where H is magnetic field intensity, T is plasma temperature, c is velocity of light in a vacuum, and e is electron charge. An attempt was made to show the presence of the instability in totally ionized low-pressure plasma in a strong magnetic field ($p \ll H^2/8\pi$) with uniform power lines along the z axis. In such a case the plasma density gradient dw/dx (along the x axis) causes the instability. The turbulence caused by the above instability exhibits a diffusion coefficient close to the one found by D. Bohm. However, it is shown that the equation is not universal, and diffusion coefficients may vary as in the case of H^{-2}. An analysis of quasineutral two-phase (ion and electron) plasma with a density gradient showed the appearance of drift waves described by a dispersion relation. The friction forces between ion and electron gases induce oscillations in the drift waves. The analysis confirmed the anomalous $\sim 1/H$ plasma diffusion. (R.V.J.)

21175 UNIVERSAL STABILITY OF AN INHOMOGENEOUS PLASMA IN A MAGNETIC FIELD. A. A. Galeev, V. N. Oraevskii, and R. Z. Sagdeev. Zh. Eksperim. i Teor. Fiz., 44: 903-11(Mar. 1963). (In Russian)

It is shown that a rarefied low pressure plasma confined by a magnetic field is universally unstable with respect to local short wave disturbances that do not distort the magnetic field for any ratio between the space gradients of density and temperature. An analogue of such universal instability in the hydrodynamical approximation is an instability due to the finite magnitude of the thermal conductivity along the magnetic field lines of force. (auth)

21176 CYCLOTRON INSTABILITY OF AN INHOMOGENEOUS PLASMA. A. B. Mikhailovskii and A. V. Timofeev. Zh. Eksperim. i Teor. Fiz., 44: 919-21(Mar. 1963). (In Russian)

The stability of an inhomogeneous plasma in a uniform external magnetic field is investigated at frequencies that are multiples of the ion cyclotron frequency. It is shown that perturbations with a wave length smaller than the ion Larmor radius may be unstable. (auth)

21177 INTERACTION OF FAST PARTICLES WITH LOW FREQUENCY PLASMA OSCILLATIONS. V. N. Tsytovich (Lebedev Inst. of Physics, Moscow). Zh. Eksperim. i Teor. Fiz., 44: 946-56(Mar. 1963). (In Russian)

The effect of low frequency oscillations on fast particles passing through a plasma is considered. The calculations are performed for arbitrary particle velocities, in particular ultrarelativistic velocities, and also for arbitrary constant magnetic field. (auth)

21178 EFFECT OF COLLISIONS ON THE DISTURBANCES AROUND A BODY MOVING IN A PLASMA. L. P. Pitaevskii (Inst. of Physical Problems, Academy of Sciences, USSR). Zh. Eksperim. i Teor. Fiz., 44: 969-79 (Mar. 1963). (In Russian)

Formulas for the Fourier components n_q of the disturbances of the electron density around a body moving in a plasma and magnetic field are deduced in various limiting cases by taking into account collisions between the ions and between the ions and another particle. The calculation is performed on basis of kinetic equations with exact collision integrals. The relation between the expressions for n_q and the plasma dielectric constant is found by taking into account space dispersion. (auth)

21179 ON THE STATIONARY STATES OF HIGH-TEMPERATURE PLASMA. THE PLASMA CYLINDER IN LONGITUDINAL MAGNETIC FIELD. E. F. Tkalich and V. S. Tkalich. Zh. Tekhn. Fiz., 32: 1418-27(Dec. 1962). (In Russian)

Stationary states of high-temperature plasma were studied in kinetic approximation. The distribution of density, azimuthal current, and other physical magnitudes along a plasma cylinder was investigated. (tr-auth)

21180 ON THE THEORY OF IONIC CURRENT IN THE PROBE. Yu. M. Kagan and V. I. Perel (Leningrad State Univ.). Zh. Tekhn. Fiz., 32: 1479-82(Dec. 1962). (In Russian)

Simple aspects of ion current theory are based on separation of plasma around a probe into quasilinear and space-charge regions, resulting in 2 equations for the current on a spherical probe. One formula was developed for the surface current postulating that a potential exists at the boundary layer of the order of (kT_e/e) and that ions

wave a normal incidence to the surface. The other formula represents the $^3/_2$ law for determining the radius of an r_θ layer, assuming the electron concentration could be neglected when compared to the ion concentration. A simplified verification is given for the ion current theory. (R.V.J.)

21181 ENERGY SPECTRA OF ELECTRONS IN TOROIDAL DISCHARGE OF "BETA." E. A. Lobikov and A. I. Nastyukha. Zh. Tekhn. Fiz., 32: 1492-3 (Dec. 1962). (In Russian)

Measurements were made of electron energy spectra in a toroidal plasma; using the luminescence lines of O III, O IV, and O V. At the discharge center $E_0 = 35$ ev; at 50, 90, and 110 mm from the center $E_1 = 35$, $E_2 = 33$, and $E_3 = 25$ ev; the tail electrons of 100 to 120 ev form the O IV → O V → O VI transitions, resulting in a dip in the spectral lines. (R.V.J.)

21182 ON THE EQUILIBRIUM STATE OF A RING PINCH. V. D. Shafranov. Zh. Tekhn. Fiz., 33: 137-44 (Feb. 1963). (In Russian)

An attempt was made to develop magnetohydrodynamic equations for the equilibrium state of a toroidal plasma pinch with ideal electric conductivity. The problem postulates that the temperature is constant and an external electric field is imposed on the axially symmetric radial plasma pinch. (R.V.J.)

21183 ON THE STABILITY OF A LIQUID NON-IDEALLY CONDUCTING CYLINDER IN A MAGNETIC FIELD. Yu. V. Vandakurov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 145-9(Feb. 1963). (In Russian)

The stability of an incompressible, finite-conductivity cylinder placed in a homogeneous, axial magnetic field was investigated. It is postulated that the longitudinal current in the equilibrium cross section is constant. The long-wave perturbations are considerably worse in a finite-conductance cylinder than in an ideally conducting cylinder. (tr-auth)

21184 STRONG FOCUSING FOR THE STABILIZATION OF STRAIGHT AND TOROIDAL DISCHARGES. M. L. Levin and M. S. Rabinovich. Zh. Tekhn. Fiz., 33: 164-72 (Feb. 1963). (In Russian)

A simple method based on Lagrange formalism was used in an investigation of long-wave pinch motion in external fields. The method was also used in studies of plasma ring dynamic stabilization. (tr-auth)

21185 NOISES IN A GAS DISCHARGE PLASMA AND INSTABILITIES OF A PLASMA COLUMN IN LONGITUDINAL MAGNETIC FIELD. A. R. Akhmedov and A. A. Zaitsev (Moscow State Univ.). Zh. Tekhn. Fiz., 33: 177-82(Feb. 1963). (In Russian)

The plasma noise spectra in longitudinal magnetic fields were developed. Rotation frequencies of a helical positive column were measured and compared with theory. Critical magnetic field magnitudes that excite instabilities in the positive column are in agreement with the law of similarity. (tr-auth)

21186 A METHOD FOR MEASURING ENERGY DISTRIBUTION OF PARTICLES LEAVING PLASMA. D. G. Bulygihskii, B. V. Galaktionov, K. A. Dolmatova, and V. A. Ovsyannikov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 183-90(Feb. 1963). (In Russian)

A retarding potential method described by V. A. Ovsyannikov et al. (Zh. Tekhn. Fiz., 31: 577(1961)) was used for measuring the energy distribution of electrons and ions leaving plasma in a magnetic field. (tr-auth)

21187 SPECTROSCOPICAL MEASURE OF ELECTRON TEMPERATURES IN "ALFA". A. N. Zaidel, G. M. Malyshev, and E. A. Ptitsyna (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 200-4(Feb. 1963). (In Russian)

Plasma electron temperature in the alpha installation was measured on the basis of O, N, and C admixture line intensity ratios. The electron temperature maximum varied from 2 to 13 ev. (tr-auth)

21188 MASS ANALYSIS OF THE FLUX OF NEUTRAL PARTICLES EMITTED BY THE "ALFA" PLASMA. V. V. Afrosimov, I. P. Gladkovskii, A. I. Kislyakov, and M. P. Petrov (Ioffe Inst. of Physics and Tech., Leningrad). Zh. Tekhn. Fiz., 33: 205-11(Feb. 1963). (In Russian)

A mass analysis of 500 ev to 5 kev neutral particles emitted by the Alpha installation plasma was carried out using the time-of-flight device described by V. V. Afrosimov et al. (Zh. Tekhn. Fiz., 30: 1456(1960)) equipped with a mass spectrometer. A large number of admixture atoms was observed in the fast neutral particle flux. The energy distributions of C and N atoms and the magnitude of the atomic flux were measured at given energies. A considerable increase in plasma impurities was observed. (R.V.J.)

21189 ENERGY TRANSFER TO THE WALL OF A CHAMBER IN "ALFA". S. A. Belskii, E. V. Myakinin, A. M. Petrov, A. M. Romanov, and V. V. Yurev. Zh. Tekhn. Fiz., 33: 212-13(Feb. 1963). (In Russian)

Semiconductors and integral type wire bolometers were used for measuring the energy transfer to the walls of the Alpha device. The measurements indicated that the largest part of the energy transfer is by the particles, not by electromagnetic emission. This was confirmed by data obtained on the Alpha neutral particle flux. (R.V.J.)

21190 ON THE LAW OF SIMILARITY FOR ION SOURCES. V. I. Raiko. Zh. Tekhn. Fiz., 33: 244-5(Feb. 1963). (In Russian)

Experiments on ion beam extraction from gas discharge plasma indicated that the angular divergence of a θ beam is a function of the current density γ, and at a certain γ(d) value (d is the distance between the electrodes) the divergence has a minimum (θ_{min}). It was also shown that the law of similarities can be applied. An experimental function θ(p) (p is the similarity parameter) was developed for Na, Zn, and Pb ion beams at various magnitudes of U and γ (U_0 is the potential difference in accelerating intervals). Curves of θ(p) for various ψ ($\psi = U_k/U_0$, U_k is the chamber potential) are constructed in order to illustate the $\theta(\psi)$ function. (R.V.J.)

21191 ON THE NONLINEAR LONGITUDINAL OSCILLATIONS OF A PLASMA IN A MAGNETIC FIELD. K. N. Stepanov (Inst. of Physics and Tech., Khar'kov). Zh. Tekhn. Fiz., 33: 246-7(Feb. 1963). (In Russian)

It is shown that nonlinear longitudinal plasma oscillation frequencies in external magnetic field are not functions of amplitudes and are equal to Langmuir frequencies. (R.V.J.)

21192 ON THE STABILITY OF STABLE PLASMA OSCILLATIONS WITHOUT MAGNETIC FIELD. V. N. Oraevskii. Zh. Tekhn. Fiz., 33: 251-2(Feb. 1963). (In Russian)

Previous studies of nonlinear plasma oscillations without magnetic field showed that ion longitudinal oscillations are stable in relation to arbitrary one-dimensional perturbations while electron Langmuir oscillations are unstable. It is confirmed that the above holds not only for one-dimensional perturbations but for any type of perturbation. (R.V.J.)

21193 SOVREMENNYE METODY ISSLEDOVANIYA PLAZMY. (Modern Methods in Plasma Investigations). V. D. Rusanov. Moscow, Gosatomizdat, 1962. 185p.

A survey is made of diagnostic experiments for plasma. High-frequency methods for investigating temperatures and charged particle concentrations are described in the first section. Probe methods for measuring plasma parameters and magnetic field variations are covered in the second section. The third section deals with optical studies of basic plasma parameters and the fourth section treats plasma frequencies and plasma concentration and temperature. 175 references are included. (R.V.J.)

21194 THERMONUCLEAR POWER. T. S. Green. A Newnes Technical Survey. London, George Newnes Limited, 1963. 174p. 45/-.

A survey of the work on the controlled release of thermonuclear power is presented. The fundamentals of thermonuclear fusion and plasma physics are discussed, and the various approaches to the design of thermonuclear reactors are described. Simple physical models are used in the mathematical formulation of the problems. (D.L.C.)

21195 QUANTUM FIELD THEORETIC TECHNIQUES AND THE ELECTROMAGNETIC PROPERTIES OF A UNIFORMLY MAGNETIZED ELECTRON GAS. Leon Albert Steinert. Thesis, Boulder, Colo., Univ. of Colorado, 1962. 239p.

Field theoretic operators for the charge and current densities of the electron gas were obtained using the Darwin Hamiltonian in "second quantized" form and in the non-time retarded limit. Expressions for the charge density ρ and the current density $\vec{j}$ resulted from density matrix averaging of the corresponding operators. Temperature-dependent Green's functions were formed from certain averaged combinations of the field creation and annihilation operators. Equations of motion were obtained for the Green's functions, and ρ and $\vec{j}$ were written in terms of the Green's functions. Thus ρ and $\vec{j}$ are in a form showing both explicit and implicit dependence upon the electromagnetic potentials. In order that ρ and $\vec{j}$ might be expressed explicitly in terms of the perturbing field, formal functional series expansions were obtained for ρ and $\vec{j}$ in terms of the potentials. Connecting relations obtained from the requirement of gage invariance and from the equation of continuity were used to show that ρ and $\vec{j}$ reduce to functionals of the electric field alone. This result applies generally. Regarding the equilibrium state of the electron gas as the unperturbed state, calculations were obtained giving $\vec{j}$ explicitly to an order linear in the perturbing electric field. The results are given in the "self-consistent field" approximation, i.e., exchange and other higher order quantum effects are ignored. Specific calculations are given for a zero temperature gas and for classical high temperatures. Other related quantities discussed briefly are the energy density and the chemical potential. Considerations on the "dielectric screening" of a test charge by a magnetized electron gas are outlined. The equation of motion for the "spin magnetization" was obtained quite simply from equations of motion for Green's functions. Brief mention is made of diagrammatic techniques. (Dissertation Abstr. XXIII, No. 8)

21196 ČERENKOV RADIATION FROM AN ANISOTROPIC PLASMA. Richard Jay Kenyon. Thesis, Urbana, Ill., Univ. of Illinois, 1962. 102p.

The Čerenkov radiation from an anisotropic plasma due to the passage of a spacially bunched, cylindrically shaped, extended beam of electrons is evaluated. Two problems are considered: one in which the plasma is radially unbounded and the other in which the plasma is bounded by an unbounded isotropic dielectric. Solutions for the power radiated, expressed in terms of an equivalent radiation resistance, are obtained by a consideration of the appropriate electromagnetic boundary value problem. Numerical results were obtained by programming these solutions for computation by the University of Illinois digital computer, ILLIAC. An extensive set of curves of radiation resistance as a function of plasma frequency, cyclotron frequency, beam velocity, and beam radius is presented for the unbounded plasma problem. A few typical curves are presented for the bounded plasma problem. An experimental device and an experiment performed at X-band are described. The study of an anisotropic plasma points out criteria to use in a search for other material that would yield high Cherenkov interaction. (A.G.W.)

21197 RADIATION FROM SOURCES IN MAGNETO-PLASMA WITH A SEPARATION BOUNDARY. George Tyras. Thesis, Seattle, Univ. of Washington, 1962. 223p.

A class of problems of electromagnetic radiation from elementary sources in the presence of an anisotropic plasma half-space is discussed. All of the problems considered have the following common features: (a) the principal axes of the sources are always parallel to the interface, and (b) the steady magnetic field is also always parallel to the interface and either normal to or in the direction of the principal axis of the source. The work is divided into three parts. Part I is concerned with the fields of a horizontal magnetic dipole in and out of the magnetoplasma when the steady magnetic field is along the axis of the dipole. Part II is devoted to the problems of the electric current line source, and Part III is devoted to the problems of the magnetic current line sources. (A.G.W.)

21198 IMPROVEMENTS IN OR RELATING TO PLASMA CONFINEMENT APPARATUS. Peter Clive Thonemann, Henry Alexander Blevin, and Philip Alan Davenport (to United Kingdom Atomic Energy Authority). British Patent 923,016. Apr. 10, 1963. Filed Feb. 9, 1961.

A plasma confinement apparatus is designed which comprises a vessel, means for producing a rotating r-f magnetic field in the vessel, and means for producing a stationary magnetic field normal to the rotating field. The apparatus is operated so that the electrons but not the ions in the plasma rotate with the rotating field to produce a current which interacts with the stationary field to concentrate the plasma away from the vessel walls. The rotating field is of a strength B and a frequency ω such that $\omega_{ci} \ll \omega \ll \omega_{ce}$, where ω_{ci} and ω_{ce} = ion and electron cyclotron frequencies in a field of strength B, and such that $2(ne\eta/B)^2 \ll 1$, where n = number of ions per unit volume of plasma, e = electronic charge, and η = resistivity of plasma. The stationary field is of a strength B_0 such that $N_0 e\omega < B_0$, where N_0 = total number of electrons per unit length of the plasma. (D.L.C.)

21199 PLASMA HEATING. Solomon J. Buchsbaum (to Bell Telephone Labs., Inc.). U. S. Patent 3,085,058. Apr. 9, 1963. Filed Dec. 8, 1959.

A method is given for heating a plasma in a stellarator in such a way that most of the energy is supplied to the ions. The method comprises magnetically enclosing a mixture of two gases having difference charge/mass ratios, ionizing the two gases to form a plasma, and supplying to the plasma r-f energy of frequency $\sqrt{(x_1y_2 + x_2y_1)(\omega_1\omega_2)/(x_1y_1 + x_2y_2)}$, where x_1 and x_2 = fractional amounts by weight of the two ion species, y_1 and y_2 =

ratios of electron mass/charge ratio to the ion mass/charge ratio of the two gases, and ω_1 and ω_2 = cyclotron frequencies of the two ions. The ratio of the concentrations of the two ion species should be substantially equal to the ratios of the masses of the two ion species. This resonance frequency involves the ions but not the electrons. (D.L.C.)

21200 A SYSTEM FOR HIGH-TEMPERATURE PLASMA PRODUCTION. Emil Zižka. Czechoslovak Patent 99,196. Apr. 15, 1961.

A patented system for the production of high-temperature plasma is described. It consists of a magnetic trap, two accelerating systems (each of which, in turn, consists of an electron and an ion accelerator), and an ion source. The ions, upon leaving the source, are accelerated by the ion accelerator, after which the electron and ion flows merge and result in the formation of a quasi-neutral plasma. A similar process takes place also in the other accelerator with the one difference that the plasma current, in the given case, goes to meet the other current formed by the former accelerating system. The quasi-neutral plasma counter-currents merge in the magnetic trap, and the resulting high-temperature plasma has a density that is fully sufficient for a thermonuclear reaction. The decrease of plasma density in consequence of the settling of particles on the trap walls is reduced to a minimum. The system has the following parameters: plasma density in the magnetic trap: 10^{11} to 10^{13} cm^{-3}; plasma particle energy: 100,000 to 200,000 ev; magnitudes of electron and ion currents are of the order of 10^3 amp, and magnetic field strength in the trap: 5×10^4 to 10^5 Oe. The system works in pulse operation. (Referativnyy zhurnal, Fizika, No. 10, 1962)

Shielding

21201 (NARF-62-13T) A MONTE CARLO MULTIBEND DUCT PROCEDURE. D. G. Collins (General Dynamics/Fort Worth. Div. of General Dynamics Corp., Fort Worth, Tex.). Sept. 15, 1962. Contract AF33(657)-7201. 44p. (MR-N-297)

A Monte Carlo procedure was developed to evaluate the energy, angular distribution, and intensity of either the scattered neutron or gamma-ray flux that penetrates a multibend duct. The procedure was coded for the IBM 7090. A detailed presentation of the Monte Carlo method as an approximation to the Neumann series solution of the integral transport equation is given. Sampling techniques utilized by the procedure are described. Included in these techniques are splitting, Russian Roulette, statistical estimation, and a method of biasing the sampling from the source angular distributions. Results obtained with the procedure are compared with the data taken in the duct penetration and systemization experiment conducted at General Dynamics/Fort Worth. This comparison confirms the validity of the methods. Further, it shows that the procedure will be a valuable aid in the analysis of experimental data as well as in the determination of the validity and range of applicability of some of the simpler methods developed to calculate the flux penetrating a multibend duct. (auth)

21202 APPLICATION OF THE "REMOVAL CROSS SECTION" PROCESS FOR CALCULATION OF HYDROGEN-FREE SHIELDING. D. L. Broder, A. A. Kutuzov, V. V. Levin, and V. V. Frolov. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 5: No. 12, 65-70(Dec. 1962). (In Russian)

The results of experimental research on the attenuation of a monoenergetic beam of fast neutrons in aluminum and in combinations of aluminum with Fe and Pb, plexiglass, and polyethylene are presented. On the basis of these results, the removal cross sections are calculated for Fe, Pb, plexiglass, and polyethylene. (tr-auth)

Theoretical Physics

21203 MARKOV PROCESSES AND THE H-THEOREM. Tetsuzo Morimoto (Kyoto Univ.). J. Phys. Soc. Japan, 18: 328-31(Mar. 1963). (In English)

The H-theorem is investigated in view of Markov processes. The proof is valid even in fields other than physics, since none of the physical relations, such as the principle of microscopic reversibility, the unitarity of the S-matrix, and so on, are utilized. The well-known 'Wiederkehreinwand' is also re-examined from this standpoint, and a reconciliation is regained between the H-theorem and the recurrence in the sense of probability theory. (auth)

21204 RELATIVISTIC PARTIAL WAVE EXPANSIONS FOR MULTI-PARTICLE PROCESSES. J. Werle (Univ. of Warsaw). Phys. Letters, 4: 127-9(Mar. 15, 1963). (In English)

A method for constructing complete orthonormal sets of simultaneous eigenfunctions of total energy, total momentum, and total angular momentum is presented. All the quantum numbers in this procedure are referred to the same over-all center of mass. The procedure leads to general formulas that are equally simple for any number $n \geq 3$ of particles of arbitrary mass and spin values.(C.E.S.)

21205 SPIN IN RELATIVISTIC QUANTUM MECHANICS. Bronisław Kuchowicz (Inst. of Nuclear Research, Polish Academy of Sciences, Warsaw). Postepy Fiz., 13: 613-35(1962). (In Polish)

Introductory remarks on various relativistic generalizations of the concept of spin are given. These remarks include the Lorentz group and its infinitesimal operators, standard procedure and the resultant inadequacies, and transformation to a system at rest. The review continues with the spin operator in a system at rest and the spin operator of particles in second quantization theory. The models treated lead to the occurrence of particles with nonzero rest mass. For vanishingly small rest mass, it is apparent that no rest-system exists. Further, it is not possible to assign a spin to these particles by the usual methods. (TTT)

21206 LECTURES IN THEORETICAL PHYSICS. VOLUME IV. Lectures Delivered at the Summer Institute for Theoretical Physics, University of Colorado, Boulder, 1961. Wesley E. Brittin, B. W. Downs, and Joanne Downs, eds. New York, Interscience Publishers, Inc., 1962. 628p.

Lectures in the field of nuclear theory were presented. The material contained topics on superconducting electron and nucleon systems, problems in astrophysics, Fermion theory, nuclear orientation theory, and various types of scattering theory. Separate abstracts were prepared for ten of the eleven papers presented. The paper "Mass Singularities of Feynman Amplitudes" was previously abstracted in NSA (16: 32308). (C.E.S.)

21207 SUPERCONDUCTING ELECTRON AND NUCLEON SYSTEMS. J. G. Valatin (Univ. of Birmingham, Eng.). p.1-120 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

The approach to superconducting electron and nucleon systems is connected with the self-consistent field approximation of the Hartree-Fock method. The long range correlations are described by a single factorizable term in the correlation function. The factor of this term, which is the expectation value of a pair of field operators, combined with the single-particle density matrix, describes all the

approximate ground state properties. A generalization of the density matrix form of the Hartree-Fock method is introduced. Different properties of superconducting electrons and nucleons are presented. A new matrix commutator form of the equations that makes possible a simple unified treatment of all the different effects is discussed. (C.E.S.)

21208 MINIMUM PRINCIPLES IN SCATTERING THEORY. Larry Spruch (New York Univ., New York). p.161-263 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

Background material is presented to develop some perspective toward the discrete eigenvalue problem and to record some results that will be needed later. A few methods, restricted to scattering by a static potential, are described to determine non-variational bounds on scattering parameters for potential scattering. Methods based on the minimum variational principles are discussed. Variational bounds for scattering lengths, effective ranges, and phase shifts for potential, single-channel, and multi-channel scattering are considered. (C.E.S.)

21209 PROBLEMS IN ASTROPHYSICS. M. J. Seaton (Univ. of Colorado, Boulder). p.264-323 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

Interpretation of the observed spectra of astronomical objects is considered. The problems are concerned mainly with the properties of a gas in a radiation field. The laws of thermodynamic equilibrium are assumed valid for atmospheres of gaseous nebulae, stars, and the sun. Certain information can be obtained from the observed spectra concerning the nature of the material considered — its temperature, density, and chemical composition. Then the validity of the assumptions is examined and, when necessary, a more realistic treatment is sought. (C.E.S.)

21210 TWO-COMPONENT FERMION THEORY. Laurie M. Brown (Northwestern Univ., Evanston, Ill.). p.324-57 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

An elementary, classical field approach for the two-component fermion theory is based on the derivation of the Kramers equation. Kramers equation is examined in detail and certain properties of the equation are discussed. An alternative way of solving problems in quantum electrodynamics that is simpler than the conventional method is presented and the possibility of splitting interactions into a charge interaction and a spin interaction is considered. It is then shown how the vector-axial (V-A) direct current interaction can be advantageously expressed in the two-component formalism. (C.E.S.)

21211 THEORY OF NUCLEAR ORIENTATION. Masato Morita (Columbia Univ., New York). p.358-92 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

The theory of nuclear orientation and its application are discussed. The validity of nuclear models is tested by comparing theoretical and experimental values of nuclear spins, parities, moments, and various kinds of transition matrix elements. Parity conservation, charge-conjugation invariance, and time-reversal invariance of the physical laws of nature are tested. Methods of orienting atomic nuclei and methods for calculating the various formulas in nuclear spectroscopy are considered. A new method of orienting nuclei using the Mössbauer effect and its application, and the investigation of the first excited states of even-even nuclei in terms of beta-gamma angular correlation and branching ratios of beta decays are discussed. (C.E.S.)

21212 INTRODUCTION TO THE THEORY OF SCATTERING. R. M. Thaler (Case Inst. of Tech., Cleveland). p.393-435 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

A scattering experiment on particle collisions is presented and analyzed. The radial equation is obtained from the one-body time-independent Schroedinger equation with a central potential. Standard mathematical results are derived in order to rewrite the radial equation in integral form. The radial Green's function and its application to the scattering problem are considered. The discrete and continuous spectrum are then investigated. (C.E.S.)

21213 NUCLEAR MATTER. Franz Mohling (Univ. of Colorado, Boulder). p.436-59 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

The Fermi density function that gives the momentum distribution for a gas of free fermions is introduced. Single-particle energies for nuclear matter are defined by considering variations of the system energy with respect to the Fermi density function. General requirements that any theory of nuclear matter must satisfy are outlined. Recent progress in quantum statistics and its application to nuclear matter are discussed. The Λ-transformation, under which the expressions for physical quantities in quantum statistics retain an invariance, is introduced. The methods of quantum statistics after the Λ-transformation are used to investigate the zero-temperature idealization of nuclear matter by straightforward application. Substantial qualitative information about the energy-density relation and the quasi-particle energy-momentum relation for nuclear matter are presented from the equations for the thermodynamic potential per particle. (C.E.S.)

21214 DISPERSION RELATIONS AND RESONANCE SCATTERING. A. O. Barut (Syracuse Univ., N. Y.). p.460-523 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

The dynamical approach to quantum theory based on the analytical properties of the S-matrix or the scattering amplitude is considered. The emphasis is on the nonrelativistic case, although the relativistic case is also introduced. Special attention is given to the description of resonances and bound states throughout the development. An inductive approach to the subject matter is followed and the deductive formulation is discussed at the end. (C.E.S.)

21215 THE HELICITY REPRESENTATION FOR ANGULAR MOMENTUM. Loyal Durand, III. (Yale Univ., New Haven). p.524-70 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

Development of the basic properties and advantages of the helicity representation for angular momentum is presented and systematic applications of this representation to the study of the properties of vertex functions in quantum field theory are discussed. The vertex functions for mesons (π^0) and electromagnetic currents are considered. (C.E.S.)

21216 SCATTERING OF NEUTRONS BY STATISTICAL MEDIA. Roy J. Glauber (Harvard Univ., Cambridge, Mass.). p.571-615 of "Lectures in Theoretical Physics. Vol. IV." New York, Interscience Publishers, Inc., 1962.

The manner in which the scattering of neutrons is used to obtain a picture of the time-dependent motions of nuclei within a substance is considered. Media such as liquids and gases in which the nuclei are more or less randomly placed with respect to each other are discussed. The description of the media is undertaken in statistical terms. Problems of time-dependent statistical mechanics are introduced. (C.E.S.)

REACTOR TECHNOLOGY

General and Miscellaneous

Refer also to abstracts 19722, 19745, 20171, 20401, 20402, and 20481.

21217 (CEA-1690) ETUDE DE LA FLUCTUATION DE LA POPULATION DE NEUTRONS SUR UNE PILE HOMOGENE AU PLUTONIUM. (Study of the Fluctuations in Neutron Density in a Homogeneous Plutonium Pile). C. Clouet d'Orval, E. Deilgat, J. Labbe, M. Molbert, and J. Tachon (France. Commissariat à l'Énergie Atomique. Centre d'Études Nucléaires, Saclay). 1962. 33p.

The variations in neutron density in the center of a reactor core are subjected to a statistical fluctuation phenomenon. Because of the correlations existing between the neutrons, their distribution does not follow Poisson's law. It diverges from it by a quantity depending on various parameters such as the lifetime and the effective fraction of the slowed-down neutrons. Experiments were carried out designed to demonstrate this divergence and also, more particularly, the correlation between unaffected and slowed-down neutrons; these were carried out with the help of Proserpine, a critical homogeneous plutonium assembly. (auth)

21218 (GA-3783) ADVANCED BERYLLIUM OXIDE CONCEPTS. Progress Report. (General Atomic Div. General Dynamics Corp., San Diego, Calif.). Jan. 17, 1963. Contract AT(04-3)-187. 40p.

A program was initiated to examine the future potential of beryllium oxide as a reactor moderator material. The work in the reactor physics area showed in a quantitative manner that the basic reactor physics properties of beryllium oxide result in advantages which make it a superior moderator for certain applications. The results indicate that the neutron economy in beryllium-oxide-moderated cores is outstanding because of the good moderating characteristics, its small absorption cross section, and the (n,2n) multiplication of fast neutrons. The general study led to the investigation of the physics properties of two particular concepts. The first is a potential breeder reactor using the uranium-thorium fuel cycle; the second is a relatively compact system using a mixture of the plutonium isotopes as fuel. Efforts in both the engineering and materials areas were concentrated on the design and the feasibility of manufacture of the fuel elements for the first of the two concepts. The work involved a review of the basic mechanical and thermal properties of beryllium oxide and the effects of irradiation on these properties. The major concern in both engineering design and materials is the feasibility of an all-oxide core. As one interesting possibility, the use of graphite as the structural material in the core was examined. Discussions of possible designs utilizing these developments are contained in this report. The studies demonstrated the outstanding potential of beryllium oxide in gas-cooled reactors. (auth)

21219 (GEAP-3843) SUBCOOLED BURNOUT AT HIGH FLOWS. E. Janssen and J. A. Kervinen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). [nd]. Work performed under United States–Euratom Joint Research and Development Program. Contract AT(04-3)-189. 35p. (EURAEC-592)

Activities in a program to obtain information on fuel rod burnout limit for an internally heated annulus covering high subcooling and flow rates are described. Details of an out-of-pile test program are included along with data concerning the effects of pin-type rod spacers on burnout. Recommendations are also included. (J.R.D.)

21220 (GEAP-4028) A FUEL REPROCESSING PLANT FOR FAST CERAMIC REACTORS. H. W. Alter (General Electric Co. Vallecitos Atomic Lab., San Jose, Calif.). Feb. 1, 1962. Contract AT(04-3)-189. 25p.

A study was made of the adaptation of the HAPO anion exchange process to the reprocessing of Fast Ceramic Reactor (FCR) fuel using the Idaho Small Plant Concept. It is shown that the anion exchange flowsheet meets the reprocessing objectives of the FCR case and can be adequately accommodated in the Small Plant Concept. Capacities of up to 1550 Md(e) are feasible in the Small Plant and unit reprocessing costs range from 0.14 to 0.28 mills/kwh depending on the number of reactors to be processed. (auth)

21221 (GEAP-4159) FUEL CYCLE PROGRAM. A BOILING WATER REACTOR RESEARCH AND DEVELOPMENT PROGRAM. Tenth Quarterly Progress Report, October–December 1962. C. L. Howard, comp. (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 14, 1963. Contract AT(04-3)-189. 72p.

Progress in the fuel cycle program to improve the technological limits of boiling-water reactors is reported. Irradiation of special and basic fuel assemblies is being carried out in VBWR for power-limit tests. A leak in the VBWR recirculation piping resulted primarily from mechanical and thermal plastic strain cycling. Metallographic examination of Zircaloy-clad fuel rods at the points of fretting against the wire spacers showed that mechanical wear rather than chemical attack is the dominant effect observed. Two spacers were designed to prevent fretting. Stainless steel-clad UO_2 fuel was fabricated. Measurements in a stability loop of oscillations of flow velocity at the entrance to the electrical heater section showed that the measured frequencies did not match the calculated resonant frequencies. This was interpreted to mean that the loop was being driven by some excitation such as the dynamic boiling process. A four-rod test section is being fabricated for heat-transfer and fluid-dynamic tests. Chemical analyses of the radial variation in isotopic composition within a fuel rod are in progress. (M.C.G.)

21222 (IDO-16845) A PYROLYTIC CAPSULE DESIGN FOR FILM FORMATION STUDIES. E. Burroughs, S. Cohen, and W. B. Lewis (Phillips Petroleum Co. Atomic Energy Div., Idaho Falls, Idaho). Mar. 15, 1963. Contract AT(10-1)-205. 21p.

The Pyrolytic Capsule Fouling Test (PCFT) apparatus which was built to study organic film formation on a heated surface under gamma irradiation, is described. Preliminary testing of the capsule and auxiliary equipment indicated that film formation studies could be made with the apparatus under closely controlled conditions, with or without gamma irradiation. In addition, the capsule was useful for heat transfer studies. (auth)

21223 (NAA-SR-8140) EFFECTS OF TUBE LEAKS IN SODIUM-HEATED STEAM GENERATORS. M. A. Salmon (Illinois Inst. of Tech., Chicago. Armour Research Foundation). Apr. 15, 1963. For Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif. Contract AT(11-1)-Gen-8. 105p.

Methods for estimating upper bounds on the dynamic and

thermal effects of steam-to-Na leaks in steam generators with single-walled tube bundles are presented. These methods are applied to a 30-Mw steam generator design to assess the seriousness of leak hazards. Estimates of pressure based on the assumption of the complete failure of a single tube are made and the maximum pressure is found to be in the neighborhood of the failure pressure of the vessel. The conclusion is reached that a more refined analysis is required to demonstrate the adequacy of the present design and courses of action recommended if further investigations are made. (auth)

21224 (NYO-10478) QUARTERLY PROGRESS REPORT ON EVALUATION OF AUTOMATIC FLOW BALANCING DEVICE IN BOILING WATER REACTORS, DECEMBER 1962–MARCH 1963. Report No. 379. R. L. Mela, D. A. Gall, E. F. Doyle, and J. A. O'Neil (Dynatech Corp., Cambridge, Mass.). Apr. 1963. Contract AT(30-1)-2907. 19p.

Progress on the development of an integral fuel element control device is discussed. The experimental high pressure loop is described. Theoretical predictions of the experimental flow control system are presented. (auth)

21225 (TID-7658) PROCEEDINGS OF THE NUCLEAR SUPERHEAT MEETING, NO. 7, SEPTEMBER 12, 13 AND 14, 1962, SIOUX FALLS, SOUTH DAKOTA. (Chicago Operations Office, AEC). Oct. 30, 1962. (COO-266)

Proceedings of the Seventh AEC-sponsored Nuclear Superheat Meetings are presented. Topics covered by the 35 papers include: out-of-pile superheat cladding corrosion-erosion and coolant chemistry tests; superheater fuel fabrication, irradiation, and activation results; BORAX-V operating results; superheat reactor physics studies; superheat in-core instrumentation development; steam-water separation and heat transfer; reactor design studies; and reactor construction status. Separate abstracts were prepared for 33 papers. (M.C.G.)

21226 (TID-7658(p.1-14)) SUPERHEATER CORROSION TEST, 2000-HOUR INTERIM REPORT. C. Bergen (Allis-Chalmers Mfg. Co., [Milwaukee]).

Dynamic and static corrosion tests of 316L stainless steel tubing in superheated steam were carried out to evaluate stress corrosion resistance of superheater element under environmental conditions of Pathfinder Operation. Shallow cracking due to locally impure alloy was observed in a stagnant steam environment. Some local intergranular corrosion was noted in the nonheated section. No deformation or bowing was noted at any time. (M.C.G.)

21227 (TID-7658(p.14-16)) EFFECTS OF OXYGEN AND SURFACE TREATMENT ON THE CORROSION OF STAINLESS STEEL IN SUPERHEATED STEAM. W. E. Ruther and S. Greenberg (Argonne National Lab., Ill.).

The effect of surface treatment on the corrosion behavior of stainless steel is being studied. Wet ground and electropolished samples of 304, 316, 321, and 347 stainless steel and other high-temperature alloys were tested in dry and moist oxygen and in deoxygenated and oxygenated steam. In dry oxygen only type 316 showed any sensitivity to surface preparation, with the electropolished specimen showing about 6 times the metal loss of a wet-ground sample. There was a marked sensitivity to surface preparation for all four steels in wet oxygen at 650°C. The electropolished surfaces were consistently the worst. A marked difference in corrosion behavior of wet-ground and electropolished surfaces was noted in deoxygenated superheated steam tests at 650°, 600 psi. At an oxygen content of 0.03 ppm, defirmed metal loss ranged from 15 mg/dm^2 for wet-ground surfaces to 1167 mg/dm^2 for electropolished surfaces. In a few cases a sharp difference was also found in oxygenated (30 ppm) steam. (M.C.G.)

21228 (TID-7658(p.16-20)) CORROSION-EROSION AND DRYER-PREHEATER TESTS FOR THE BONUS REACTOR. G. Brown (General Nuclear Engineering Corp., Dunedin, Fla.).

Tests were completed on an unheated typical BONUS superheater fuel assembly in a steam environment. It was learned from these tests that low area (high-contact loads), spring-like spacers are not acceptable. It was concluded that a more rigid, larger-area spacer should be used. Testing of heat exchangers to dry and preheat steam before it enters the reactor superheater was also completed. Results of the preheater test indicated that deposition of chlorides and other solids in the nuclear superheater will be reduced by factors of hundreds by use of these units. (M.C.G.)

21229 (TID-7658(p.20-6)) CYCLING CORROSION TESTS. G. Gaul (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Stressed type 304 stainless steel sheaths exposed in the CL-1 superheat facility to a routine of cycling the power to the superheater sheaths resulted in numerous transgranular cracks on the entrance sheath and some localized evidence of intergranular attack on the middle and exit sheaths. Cycle tests using Hastelloy X, Inconel, and Incoloy as superheater cladding were made in CL-1 and CL-4. Neither nondestructive nor metallurgical examination showed any damage greater than 0.001 in. This damage, while localized, did not appear to be associated with stress corrosion cracking. Chloride salts appeared to increase the general corrosion rates. Data are presented in tables. (M.C.G.)

21230 (TID-7658(p.27-47)) EFFECTS OF SUPERHEATED STEAM AND OF NEUTRON IRRADIATION ON IRON- AND NICKEL-BASE ALLOYS. H. Pessl (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A program of screening and evaluation of iron and nickel alloys in support of the Plutonium Recycle Test Reactor is described. Corrosion tests were carried out in deionized, oxygenated (3 to 4 ppm O_2) and deoxygenated (<0.05 ppm O_2) steam at 550°C and 1000 and 3000 psi. Ferritic stainless steels and Fe–Cr–Al–base alloys seemed to offer better resistance in oxygenated steam with increasing exposure time. The opposite apparently applied to the austenitic stainless steels and nickel-base alloys which were more resistant to deoxygenated steam. Results indicated a slight decrease in corrosion rate when the steam pressure was increased from 1000 to 3000 psi. The effects of neutron irradiation on the mechanical properties of nickel alloys and stainless steels were determined. Atmospheric test results did not indicate pronounced property changes due to irradiation except for considerable losses in strength and elongation of the precipitation-hardened alloys. Testing at 700°C revealed more severe irradiation effects with increasing neutron flux exposure. Results are presented in graphs and tables. (M.C.G.)

21231 (TID-7658(p.48-56)) STATUS OF BORAX-V SUPERHEAT FUEL FABRICATION, INSPECTION, AND ASSEMBLY. W. Kramer (Argonne National Lab., Ill.).

The superheater fuel for the BORAX-V reactor is being inspected and assembled. A fuel assembly consists of 5 brazed subassemblies in insulating cans heliarc welded together. The cladding material is 304L stainless steel. Clad core and end cladding samples from the fuel plates were corrosion tested in ambient distilled water and de-

gassed steam for 3 days. Reddish-brown corrosion stains appeared on the surfaces of the samples in room-temperature water. The samples in steam were not significantly attacked. Brazing studies were conducted on type 406 stainless steel. Braze alloys containing phosphorus did not braze the stainless steel satisfactorily whether or not scale formation on the surface was prevented. Coast Metals 60 and two gold alloys formed good, consistent fillets with stainless steel if the steel was first descaled and nickel plated. (M.C.G.)

21232 (TID-7658(p.56)) DESIGN AND DEVELOPMENT OF EXPERIMENTAL MULTITUBE BOILING-SUPERHEATING FUEL ELEMENTS. H. Lichtenberger (Combustion Engineering, Inc., Windsor, Conn.).

Design, development of fabrication techniques, and building of mockups of multitube boiling-superheating fuel elements are being continued. UO_2 is used as the fuel material. Stainless steel, Hastelloy X, and Inconel are being used for cladding and steam tubes. (M.C.G.)

21233 (TID-7658(p.57)) DEVELOPMENT OF FABRICATION TECHNIQUES FOR ANNULAR BOILING-SUPERHEATING FUEL ELEMENTS WITH ALTERNATE CLADDING MATERIALS. H. Lichtenberger (Combustion Engineering, Inc., Windsor, Conn.).

Problems in the fabrication of the NUSU fuel element, an annular fuel section with boiling water on the outside and superheated steam on the inside, are discussed. Assembly of members with shrink fits and welding of dissimilar metals are described. (M.C.G.)

21234 (TID-7658(p.58-9)) SUMMARY OF E-SADE OPERATIONS. R. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Nonfueled testing of the E-SADE loop in VBWR began May 27, 1962, and the first fuel loading (ESH-1) was installed July 17, 1962. No serious operational difficulties were encountered with the system. (M.C.G.)

21235 (TID-7658(p.59-77)) SUPERHEAT FUEL FABRICATION, IRRADIATION, COOLANT CHEMISTRY, AND MATERIAL PROPERTY INVESTIGATIONS. C. Spalaris (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Fuel elements for E-SADE were made using Incoloy, Hastelloy X, and Inconel tubing without significant fabrication difficulties. Materials for EVESR fuel were ordered. Tests of irradiated cladding materials in 750°F steam showed little change in tensile properties, including ductility. The cumulative neutron flux above 1 Mev was 6×10^{19} nvt. Strain cycle tests showed that irradiation decreases the number of cycles to failure at a given strain range by about $\frac{2}{3}$ of the nonirradiated cases for 304 stainless steel at 1300°F. Fission-product release during reactor exposure was investigated. (M.C.G.)

21236 (TID-7658(p.77-8)) AEC-EVESR FUEL DEVELOPMENT. R. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

The EVESR reactor facility was designed and built specifically for experimental development of nuclear superheat fuel elements. A program, strongly oriented toward the solution of the stress corrosion cracking of claddings, is described. (M.C.G.)

21237 (TID-7658(p.79-82)) NUSU AND BONUS IN-PILE TESTS. S. Weems (General Nuclear Engineering Corp., Dunedin, Fla.).

The NUSU in-pile test element is an annular fuel section combination boiling and superheating fuel element. The test specimen was exposed for 42 days. Water in-leakage reached a maximum of 20 lb/hr. Although the fuel element was subjected to extensive thermal cycling during the test, no significant damage or distortion was found. Corrosion of the Inconel-X (next to the superheated steam) was limited to a uniform scale about 0.25 mil thick. There was no evidence of localized corrosion or cracking. The feasibility of this type fuel element was indicated. An irradiation test of a BONUS reactor type superheater fuel rod was planned. The stabilized austenitic stainless steel cladding thickness is small enough to be of the "collapsed clad" type. Conditions for the test are described. (M.C.G.)

21238 (TID-7658(p.82-9)) ALLIS-CHALMERS' PROJECTS IN SUPERHEATER FUEL DEVELOPMENT. D. A. Patterson (Allis-Chalmers Mfg. Co., Milwaukee).

Superheater fuel development for Pathfinder and ESH-4 assembly for E-SADE is described. Low enrichments and high enrichments for Pathfinder are discussed. (M.C.G.)

21239 (TID-7658(p.90-1)) STATUS OF BORAX-V OPERATION. R. Rice (Argonne National Lab., Ill.).

On March 9, 1962, a full loading of 60 fuel assemblies was readied in the boiling core. Control rods were calibrated by using boric acid solution in the moderator water to permit almost full withdrawal of the control rod. The measured reactivity worth of equally distributed simulated voids was unexpectedly high. Detailed flux mapping, both axial and radial, was accomplished, and a number of Cd ratio measurements were made. The electrically heated, high-temperature preoperational tests were completed Sept. 8, 1962, and time-temperature critical experiments were started Sept. 12, 1962. Twelve of the BORAX-V central superheater fuel subassemblies, without lower nozzle and upper riser, were used in ZPR-II as part of the fuel for a central superheater critical experiment. (M.C.G.)

21240 (TID-7658(p.92-5)) BORAX-V OPERATING EXPERIENCE. J. Cerchione (Argonne National Lab., Ill.).

Following completion of the cold critical experiments in May 1962, the 60-assembly core and source were removed from the reactor and stored. Difficulty was experienced in the boron addition system caused by crystallization of boric acid. An attempt to heat the reactor for preoperational plant tests was unsuccessful in June 1962, due to inability to maintain good-quality water in the reactor. Subsequent investigation disclosed multiple failures in the sheaths of immersion-tupe auxiliary water heaters. The heaters were redesigned. The control rod seals were rebuilt and cleaned. The reactor core was reloaded in July. (M.C.G.)

21241 (TID-7658(p.96-8)) BORAX-V COLD CRITICAL EXPERIMENTS. J. Hagen (Argonne National Lab., Ill.).

Rod calibrations in BORAX-V were carried out as boric acid was added in discrete steps so as to achieve criticality with all rods in a bank at several different heights. The total available excess reactivity was found to be about 12% and the shutdown margin to be about 7%. These compare with calculated values of 13.5 and −14.4% respectively. A measurement was made of the temperature coefficient with boric acid present and with the aid of electric heaters. Over the range of 79 to 101°F, a value of $-0.005\%\ \Delta k/k$ was obtained. Steam voids were simulated by the use of $\frac{1}{4}$-in. OD × 0.035-in. thick walled aluminum tubing with ends sealed and inserted into water channels. Reactivity effects of removing fuel rods and entire assemblies were assessed. (M.C.G.)

21242 (TID-7658(p.99-100)) PHYSICS OF THE HANFORD GRAPHITE SUPERHEAT REACTOR. G. Bailey (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

The engineering design of the Hanford Graphite Superheat Reactor determined the fuel-to-coolant ratio. The physics design determined an optimum ratio of water, graphite, and fuel. It was designed to achieve full benefit of the characteristics peculiar to dual moderator reactors. The fuel management plan has fuel discharged from discrete blocks of tubes. All tubes in each block are at essentially the same power. (M.C.G.)

21243 (TID-7658(p.101-12)) MIXED SPECTRUM SUPERHEAT REACTOR CRITICAL EXPERIMENT. K. Hikido (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

The mechanical design of the Mixed Spectrum Superheat Critical Assembly is described. It is designed to be a low-power mockup of the 75 Mw(e) Mixed Spectrum Superheat Reactor prototype. The core consists of 4 regions: central unmoderated fast core, annular unmoderated fast buffer, annular moderated thermal buffer, and annular moderated thermal core. The unmoderated central region is separated from the thermal, water-moderated region by two $^3/_8$-in. thick cylindrical aluminum walls with a $^3/_8$-in. gap between the walls. The 16 fused fuel assemblies each consist of 24 standard fuel rods, one fused rod, and 16 Inconel filler rods mounted in an Inconel channel. The standard fuel assemblies contain an additional standard fuel rod instead of a fused one. (M.C.G.)

21244 (TID-7658(p.112-14)) STATE-OF-THE-ART OF REACTOR PHYSICS ON SUPERHEATING REACTORS. M. F. Valerino (General Nuclear Engineering Corp., Dunedin, Fla.).

A program was initiated to evaluate the state-of-the-art of physics analyses of superheat reactor cores. The evaluation will include: compilation of critical experiment results, comparison of calculational techniques, and application of techniques to selected experimental data. (M.C.G.)

21245 (TID-7658(p.115-19)) PATHFINDER. R. Klecker (Allis-Chalmers Mfg. Co., Milwaukee).

The design of thermal and nuclear instrumentation for the Pathfinder superheater is described. Miniature ion chambers and flux wires for use in each of 3 fuel-element locations and thermocouples for 5 superheater elements are discussed. Diagrams are included. (M.C.G.)

21246 (TID-7658(p.119-22)) BORAX-V. E. J. Brooks (Argonne National Lab., Ill.).

One BORAX-V instrumented boiling fuel assembly was fabricated and a second one is being reworked. Sample fuel rod thermocouples to work at temperatures to 5000°F are being fabricated of W/W–26% Re wires, ThO_2 insulation, and W–26% Re sheathing. The design of miniature ionization chambers for spectrum and mapping applications is described. (M.C.G.)

21247 (TID-7658(p.122-3)) BONUS. J. M. West (General Nuclear Engineering Corp., Dunedin, Fla.).

No in-core instrumentation is planned for the BONUS reactor. Out-of core instrumentation provides information on power output. Reactivity and power distribution measurements were made in critical experiments on a mockup of the BONUS core. (M.C.G.)

21248 (TID-7658(p.123-33)) E-SADE AND EVESR. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Steam flow rate, steam line pressure, pressure drop across the in-core portion, and steam temperatures are measured in the E-SADE loop of VBWR. Steam from each fuel element is sampled to detect fuel clad ruptures. The loop is protected from improper handling or overpower by the control system logic which can scram or cause a rod run in the VBWR. Thirty-two fuel assembly steam flows, pressures, and temperatures are measured in EVESR. Local heat generation in the nine fuel elements in each of the fuel assemblies will be calculated along with the fuel cladding temperature. To check and correct the analytical techniques, extensive in-core instrumentation is planned. (M.C.G.)

21249 (TID-7658(p.134-8)) STEAM-WATER SEPARATION. R. Klecker (Allis-Chalmers Mfg. Co., Milwaukee).

An air-water loop was designed to develop steam separators and to investigate hydrodynamic conditions above a simulated core. Maximum permissible steam release rate, steam bubble carry-under, steam dryer characteristics, and performance characteristics of the steam separators developed in the air-water loop will be investigated in a steam-water loop. Diagrams are included. (M.C.G.)

21250 (TID-7658(p.139-45)) STEAM-WATER SEPARATION. R. H. Moen (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Two air-water and one steam-water loops were used in the development of an internal radial-vane separator. Results from a full-circle radial-vane separator using six 18-in. inlet nozzles showed an extremely rapid decrease of carry-under as flow per nozzle increased and the pressure drop increased with about the second power of flow rate per nozzle. Results indicated that the radial vane separator can operate successfully as an internal steam separator. (M.C.G.)

21251 (TID-7658(p.145-53)) ADDITIONAL HYDRODYNAMIC TEST DATA FROM EBWR AT POWERS TO 60 MW. M. Petrick (Argonne National Lab., Ill.).

A second series of hydrodynamic tests were completed on EBWR at power levels up to 60 Mw. The subcooling of the EBWR reached a peak of 2.5°F at 40 Mw and then began to drop with increasing power up to 60 Mw. At higher powers, the recirculation flow rates were substantially lower than the calculated values assuming no carry-under. Vapor carry-under remained fairly constant as the power was increased up to 40 Mw. Above 40 Mw, the carry-under increased rapidly. Data are presented in graphs. (M.C.G.)

21252 (TID-7658(p.153-5)) HEAT TRANSFER TO SUPERHEATED STEAM IN ANNULAR FLOW AT HIGH PRESSURE. R. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

Heat transfer coefficients were measured on the inner surface of 3 annular assemblies. An appreciable L/D effect on the Nusselt number persisted out to L/D values of 865. Heat transfer for the spiraled tube annulus was higher than that for a straight annulus. Equipment and data reduction are discussed. (M.C.G.)

21253 (TID-7658(p.156-7)) WESTINGHOUSE SUPERCRITICAL LOOP. P. Cohen (Westinghouse Electric Corp., Pittsburgh).

The design of a supercritical pressure loop is described. The 4000 psi loop to study heat transfer in the supercritical region was developed as a closed-cycle system with heaters and cooler. (M.C.G.)

21254 (TID-7658(p.158-62)) BOILING-SUPERHEATING MULTITUBE FUEL ELEMENT CONCEPT. S. Turner (General Nuclear Engineering Corp., Dunedin, Fla.).

The concept of an annular multitube combination boiling-superheating fuel element is being developed. Advantages of this concept are discussed. Prototype elements are being fabricated for testing in the SADE loop of the VBWR. A study was made of the operating characteristics of a multitube design. (M.C.G.)

21255 (TID-7658(p.162-6)) DESIGN STUDY OF A 600 MW(e) BOILING WATER—SEPARATE SUPERHEAT REACTOR PLANT. R. Schmidt (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.).

A 607 Mw(e) Boiling Water–Separate Superheat Reactor Plant was designed and costed. The plant consists of a boiling-water reactor, a separate superheat reactor, and two turbine generator units. Fuel element and assembly, process tubes, mechanical arrangement, plant control, startup and shutdown procedure, safety, feasibility, and power-generation costs are discussed. Power cost was calculated to be 5.46 mills/kwhr. (M.C.G.)

21256 (TID-7658(p.166-70)) HANFORD SUPERHEAT POWER REACTOR PROGRAM. H. R. Kosmata (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.).

A graphite-moderated pressure tube reactor design with a single reversing coolant path is being studied. Power outputs of 300 and 1000 Mw(e) are being investigated. The graphite blocks are cross stacked in an horizontal array and the stack is pierced by vertically oriented process tubes and control elements. Power generation costs were calculated to be 5.92 and 4.70 mills/kwhr for the 300 and 1000 Mw(e) reactors respectively. (M.C.G.)

21257 (TID-7658(p.171-2)) 1000 MW(e) SUPERCRITICAL PRESSURE REACTOR. S. N. Tower (Westinghouse Electric Corp., Pittsburgh).

Two supercritical pressure graphite-moderated reactors employing once-through heat transfer were evaluated for economic potential and overall feasibility. One concept consists of a metal-clad fuel located inside pressure tubes with an external graphite moderator. The other concept has the fuel located in the graphite moderator external to the coolant tubes. As a result of evaluations the concept with metal-clad fuel inside pressure tubes with external graphite moderator, known as the Supercritical Once-Through Tube Reactor (SCOTT-R), was chosen for continued development. (M.C.G.)

21258 (TID-7658(p.173-6)) BONUS. J. M. West (General Nuclear Engineering Corp., Dunedin, Fla.).

Construction of the BONUS Reactor is discussed. Reasons for delays are outlined and the ways in which they were handled are described. (M.C.G.)

21259 (TID-17005) KINETIC STUDIES OF HETEROGENEOUS WATER REACTORS. Quarterly Progress Report for Period Ending September 30, 1962. Report No. 21. W. W. Brown, L. Wentz, R. W. Wright, G. C. K. Yeh, and S. M. Zivi (Space Technology Labs., Inc. Physical Electronics Lab., Canoga Park, Calif.). Oct. 11, 1962. Contract AT(04-3)-372. 47p.

Two experiments were designed and built, in preparation for the measurement of transient steam void formation and extreme pressure pulses during severe power excursions under reactor-like conditions. The preparations for an in-pile capsule experiment to be carried out using the KEWB reactor as a source of pulsed neutrons are described. The water-filled capsule, exposed to neutron flux, will contain a uranium-bearing plate. Transient heating of the plate will produce a surface temperature transient which is characteristic of a severe power excursion in a heterogeneous water reactor. Measurements of steam formation rates will be applicable to the destructive transients presently underway in the SPERT-I reactor. The second experiment is an out-of-pile apparatus in which an attempt will be made to create severe pressure transients by causing the temperature of a surface to rise rapidly through the thermodynamic critical point of water. Studies related to boiling-water reactor stability were continued. Transfer function and steam void fraction distribution measurements were made. An analysis indicated that a multi-channel natural circulation boiling system may have two modes of hydrodynamic instability. (M.C.G.)

21260 (UCRL-10614) REACTIVITY LIFETIME AND BURNUP IN NUCLEAR FUELS (thesis). Jean Robert Lefebvre de Ladonchamps (California. Univ. of Berkeley. Lawrence Radiation Lab.). Jan. 7, 1963. Contract W-7405-eng-48. 213p.

Analytical methods for the prediction of the reactivity lifetime and burnup of nuclear fuels are developed. The analysis applies to those nuclear fuels whose changes in composition with time are due solely to neutron-absorption processes, so that the composition of any fuel species is a function only of the integrated flux time of its irradiation exposure. Reactivity lifetime can then be expressed as a function of the appropriate average flux time of the fuel at the end of the irradiation. Local and average burnup of the irradiated fuel are calculated without necessarily specifying the magnitude of the irradiation flux or the power program of irradiation. A generalized perturbation method is developed which allows calculation of the above results, and which takes into account the spatial variation in neutron flux within the reactor and changes in this spatial variation during irradiation resulting from changes in fuel composition. Tabulated functions allow hand computations for the batch irradiation of fixed fuel in cylindrical or spherical reactors that have a uniform initial fuel loading. Such functions also apply to radial mixing and graded irradiation. The perturbation method is most easily applied to the one-group diffusion model, but the method is extended to the multigroup model with only slight modification for reactors with energy-independent boundary conditions. An exact analytical solution for the reactivity lifetime and fuel burnup was developed for continuous fueling schemes, if the one-group model applies and if the characteristic excess neutron production of the fuel varies as a quadratic function of the flux time of irradiation exposure. A comparative study of various continuous fueling schemes was made for a fuel with typical properties. The validity of the approximate solutions is determined by comparing results of the second-order perturbation method with the exact solutions of the same equations. Numerical computations on high-speed digital computers were used to obtain exact solutions of those equations that could not be solved analytically by means of elliptic functions. The computational procedures developed allow survey studies comparing the performances of various fuels and various reactor designs. Also, it predicts the magnitude of the errors to be expected when various neutron behavior models (one-group, two-group, continuous slowing down) are used in more elaborate computations on high-speed digital computers. Although attention was focused mainly on the properties related to the variations of the flux in the equivalent homogeneous fuel-moderator cell, corrections for lumped fuel were also investigated. 58 references. (auth)

21261 (WAPD-PWR-TE-148(Rev.)) DECONTAMINATION OF THE ALLIS-CHALMERS VOLUTE. W. Lechnick (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). Apr. 5, 1963. Contract [AT(11-1)-Gen-14]. 17p.

The relative effectiveness of Alconox scrubbing, electrolytic "Johnny-mop" decontamination, and alkaline permanganate ammonium citrate (APAC) decontamination was investigated during decontamination of the Allis-Chalmers volute at PWR. Electrolytic decontamination proved to be

most effective, reducing internal gamma radiation levels of the volute by an average D.F. (decontamination factor = initial radiation level/final radiation level) of 33 against a D.F. in the range of one for Alconox scrubbing and an average D.F. of 11 for APAC decontamination. Smear activity levels were reduced by an average D.F. of 80 as a result of electrolytic cleaning against a D.F. of four for Alconox scrubbing and three for APAC decontamination. Electrolytic decontamination followed by scrubbing with Alconox and water produced the best overall D.F. (auth)

21262 EVALUATION OF SELECTIVE CIRCUITS. U. Hennings (Brown Boveri Krupp Reaktorbau GmbH, Mannheim, Ger.). Atomwirtschaft, 8: 170-4(Mar. 1963). (In German)

Safety systems with selective circuits are customary, particularly in reactor construction. It is not always possible to lay out the monitoring channels as pure r-out-of-m circuits. The definition of and the differences between safety systems are discussed. Methods and formulas by which such systems can be evaluated are given. To attain increased safety the following principles are applied to the control and monitoring systems of a reactor: use of very reliable components; arrangement of components so that they fail safe; combination of several elements in selective circuits; and use of monitoring and test circuits. It is advantageous to introduce selective circuits by which the reliability of individual elements can be increased by the use of a great number of them with appropriate connections. This measure results in a corresponding increase in costs. In order to remove the uncertainty caused by the possible failure to detect immediately breakdown of an individual element in selective circuits monitoring or test circuits are introduced for the continuous function control of the selective circuits during operation. Where this is not practicable the frequency of routine checking should be adjusted according to the degree of danger resulting from failure of the individual elements. In the case of safety systems with selective circuits it is possible to distinguish between pure selective circuits (all elements equal and of equivalent status in the circuit), mixed selective circuits (here the elements used in the safety system are not in aggregate the same, each mixed selective circuit may, however, be broken down into pure selective circuits) and pre-adjusted selective circuits where the influence of the operation of the elements on safety can still be examined. In this last case channels with central preadjustment can be distinguished from those with individual pre-adjustment. Examples and definitions of all these various safety systems are given as well as the frequency and probability of failure. (auth)

21263 A METHOD FOR THE NUMERICAL INTEGRATION OF FOURIER EQUATIONS FOR THE STUDY OF THERMAL TRANSIENTS IN A FAST NUCLEAR REACTOR. Luciano Biasini (Centro di Calcolo, Bologna) and Roberto Evangelisti. Comit. Naz. Energia Nucl., Notiziario, 9: No. 2, 44-59(Feb. 1963). (In Italian)

A calculus for studying the behavior of a fast reactor under variable thermal conditions was derived. Some numerical data on cases investigated are presented. (auth)

21264 THE PRESENT STATE AND THE DIRECTIONS OF DEVELOPMENT OF NUCLEAR ENERGETICS. D. Ufer (Technische Hochschule, Dresden). Energietechnik, 12: 483-92(Nov. 1962). (In German)

The present most important atomic power plant types are described and the advantages and disadvantages are compared. The development tendencies for thermal reactors, especially to high temperature reactors, are shown. From the standpoint of fission-material economy it was established why thermal reactors are not in a position to assist in covering the energy requirements of earth for a long time. In their place the fast reactors must go. Their mode of operation is sketched briefly and an atomic power plant with fast reactor is presented. (tr-auth)

21265 REACTOR KINETICS WITH LINEARLY INCREASING REACTIVITY. I. G. Morozov, E. I. Inyutin, and G. I. Sidorov. Inzh. Fiz. Zh., Akad. Nauk Belorussk. SSR, 6: No. 1, 73-8(Jan. 1963). (In Russian)

The behavior of a nuclear reactor when the reactivity is a linear function of time is described. Comparison of the theory with experimental data is made for reactors with and without an extraneous neutron source. Calculations are made using electronic analog computer. The application of the results obtained to the startup problem is considered. (auth)

21266 A REFLECTED REACTOR WITH A FLAT THERMAL FLUX DISTRIBUTION IN THE CORE. Sadik Kakaç. Istanbul Tek. Univ. Bul., 15: 1-12(1962). (In English)

A reactor core in the form of an infinite slab contains a homogeneous distribution of fuel. There is a known neutron flux distribution in that reactor. The concentration of the fuel can be varied as a function of position. The core is surrounded by an infinite reflector of the same material as the moderator in the core, the objective is the determination of the function that gives the fuel distribution in the core. This distribution permits a flat flux of thermal neutrons in the core and derivation of the thermal and the fast flux distributions in the core and in the reflector and the critical thickness of the reactor. The results are applied to the calculation of the critical thickness of a solution of UO_2F_2 in H_2O. Finally the experimental results are investigated. (auth)

21267 TEMPERATURE DISTRIBUTION IN UO_2 FUEL ELEMENTS. J. A. L. Robertson, A. M. Ross, M. J. F. Notley, and J. R. MacEwan (Atomic Energy of Canada Ltd., Chalk River, Ont.). J. Nucl. Mater., 7: 225-62 (Dec. 1962). (In English)

Evidence is presented that the temperature distribution in fuel elements, in which the UO_2 is in pressure contact with its sheath, is well-known and predictable. The temperature drops through the fuel itself, across any cracks in the fuel, and across the fuel/sheath interface are discussed. Previous Chalk River results are confirmed and extended without significantly altering any former conclusions. The evidence suggests that only at temperatures below 600°C does irradiation significantly decrease the thermal conductivity of UO_2, up to a burn-up of at least 40,000 Mwd/ton U. Since many of the temperatures in UO_2 have been deduced from observations on grain growth, some of the factors affecting it were examined; besides the temperature, the time at temperature, the original grain size, and the O : U ratio of the fuel are all important. The data presented permit calculation of the temperature distribution in fuel elements assembled with small diametral clearances. (P.C.H.)

21268 MATERIALS FOR CONTROL ROD DRIVE MECHANISMS. An AEC Monograph. George A. Freund. Monograph Series on Metallurgy in Nuclear Technology. New York, Rowman and Littlefield, Inc., 1963. 214p. $4.45(Paper Binding), $6.95(Library Binding).

A summary of information concerning these materials is presented in chapters on general features of control rod drive mechanisms, typical designs, materials criteria, lubricants and fluids, corrosion, wear, fabrication, and compositions and properties of materials. (J.R.D.)

21269 FABRICATION OF CONTROL RODS FOR NUCLEAR REACTORS. An AEC Monograph. William E. Ray. Monograph Series on Metallurgy in Nuclear Technology. New York, Rowman and Littlefield, Inc., 1963. 235p. $4.45(Paper Binding), $6.95(Library Binding).

Information concerning the technology associated with fabrication of control rods for power reactors is presented. Chapters are included on boron stainless steels, Al–B alloys, Ti–B alloys, B dispersions, Cd alloys, Ag alloys, Hf, rare earth dispersions, absorber materials, and quality control. (J.R.D.)

21270 SEISMIC VIBRATIONS OF NUCLEAR REACTOR TYPE STRUCTURES. F. J. Witt (Oak Ridge National Lab., Tenn.), D. R. Carver, and R. L. Maxwell. p.504-19 of "Developments in Theoretical and Applied Mechanics. Vol. I." New York, Plenum Press, 1963.

The analysis of the dynamic behavior of a composite system is described. On the assumption of small oscillations and three degrees of freedom, the equations of motion are derived and solved, with special emphasis on determining the resulting stresses. Specifically, the method of analysis is applied to the composite structure (core, pressure vessel, and supporting skirt), which typifies the configuration used in nuclear reactors. General analytical solutions to the equations of motion are derived, and for a specific structure both analytical and analog solutions are computed and compared. (auth)

21271 IMPROVEMENTS IN OR RELATING TO THE OPERATION OF NUCLEAR REACTORS. Harry Norman Schludi. British Patent 922,041. Mar. 27, 1963. Priority date Apr. 14, 1960, Germany.

A method is given for operating a heterogeneous reactor at high temperatures without large temperature changes in the fuel elements. The method comprises supplying heat to the fuel elements from an exterior source, e.g., electrical means, whenever the reactor power is reduced below a predetermined level. In the fabrication of the fuel elements, the elements can be maintained above a predetermined temperature by heating until they are introduced into the reactor. (D.L.C.)

21272 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. Ronald Hugh Campbell (to United Kingdom Atomic Energy Authority). British Patent 922,222. Mar. 27, 1963. Filed Apr. 27, 1959.

An apparatus is designed for monitoring a number of coolant streams from a gas-cooled reactor for fission products as an indication of damaged fuel elements. The apparatus comprises a bank of precipitation chambers, a precipitation electrode extending through the chambers, and means for moving the electrode from the chambers to a bank of monitors. The gas inlet of each chamber is connected to a fuel element channel for continuous sampling. A cross matrix sampling system is also described. (D.L.C.)

21273 IMPROVEMENTS RELATING TO NUCLEAR REACTORS. Ronald Tunstall Ackroyd and Ben Maurice Segal (to United Kingdom Atomic Energy Authority). British Patent 922,498. Apr. 3, 1963. Filed Nov. 4, 1960.

A reactor core is designed for control simply by rotation of the fuel elements. The elements each comprise a multiplying region and a nonmultiplying region and are mounted for rotation for interchanging the positions of the regions. (D.L.C.)

21274 IMPROVEMENTS IN AND RELATING TO NUCLEAR REACTORS. Robin Arthur Underwood (to C. A. Parsons & Co. Ltd.). British Patent 922,572. Apr. 3, 1963. Filed Oct. 10, 1960.

A thermocouple arrangement for a reactor is designed with means for relieving the strain on the thermocouple cables during charging and discharging operations in the reactor. The means comprises connecting the cables together with an interweaving wire member to form a flexible flat belt which passes through a standpipe plug. (D.L.C.)

21275 IMPROVEMENTS IN/OR RELATING TO THE MONITORING OF FISSION PRODUCTS IN A GASEOUS STREAM, PARTICULARLY FOR DETECTING BURST SLUGS IN NUCLEAR REACTORS. Jean Goupil, Jean Graftieaux, and Jean Megy (to Commissariat a l'Energie Atomique). British Patent 923,083. Apr. 10, 1963. Priority date June 23, 1958, France.

A fission product monitoring system for a gas-cooled reactor is designed which is based on the collection and measurement of radioactive ions in the gaseous streams. Each stream is fed into a decay zone and then into a collecting zone, where the decay ions are collected on a rotatable drum for counting. (D.L.C.)

21276 IMPROVEMENTS IN AND RELATING TO NUCLEAR FUEL ELEMENTS. Brian Vernon Gaskell (to General Electric Co. Ltd.). British Patent 923,258. Apr. 10, 1963. Filed Jan. 18, 1961.

A reactor fuel element is designed which comprises fissile material encased in a protective can housed in a tubular carrier or sleeve, the can having heat exchange fins and one or more longitudinal splitter fins. The splitter fins are provided with means for keying to the inner wall of the tubular carrier for support while permitting longitudinal movement of the fins. Several embodiments of the fuel element are described. (D.L.C.)

21277 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR FUEL ELEMENTS. Leslie Reginald Blake (to United Kingdom Atomic Energy Authority). British Patent 923,343. Apr. 10, 1963. Filed Aug. 17, 1959.

An economical fuel element with good burnup characteristics is designed for fast reactors. The fuel element comprises a strong sheath enclosing unalloyed Pu or U fuel, and between 10 to 30% of the interior of the sheath is left empty to serve as an expansion space for the fuel and fission products. The sheath should have an outer diameter of 0.1 to 0.4 in. and a thickness of at least $^1/_{10}$ of the diameter so as to withstand an internal pressure of 10,000 psi at 600°C, and it may be made of Nimonic or Inconel for use in liquid sodium. Several embodiments of the fuel element are described. (D.L.C.)

21278 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR CHARGING METHODS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 923,633. Apr. 18, 1963. Priority date May 6, 1958, Germany.

A continuously operable charging method for heterogeneous reactors is described for obtaining uniform burnup of the fuel elements. The method comprises dividing the fuel lattice into coaxial zones equal in number to the number of banks and of differing burnup, and transposing the fuel elements from zone to zone so that each fuel element is transposed into a zone and into a bank which it has not previously occupied. (D.L.C.)

21279 IMPROVEMENTS IN AND RELATING TO SAFETY, ALARM OR LIKE CIRCUITS FOR MONITORING SYSTEMS. Peter Forsdike Hartshorn (to General Electric Co. Ltd.). British Patent 923,799. Apr. 18, 1963. Filed July 5, 1960.

A safety circuit is designed for a system which monitors a plurality of coolant streams for fission product activity in a reactor and compares cyclically the monitored signals

with a reference signal. The circuit includes means for computing the average value of a succession of monitored signals and for deriving the reference signal from the computed value. (D.L.C.)

21280 IMPROVEMENTS IN OR RELATING TO FUEL ELEMENTS FOR NUCLEAR REACTORS. Ronald Scott Challender and Alan Charles Antony Saunders (to United Kingdom Atomic Energy Authority). British Patent 923,826. Apr. 18, 1963. Filed June 27, 1960.

A fuel element of the type having helical heat transfer fins intersected by four longitudinal splitter fins is designed with self-stabilizing means against vibration in coolant flow. The self-stabilizing means consists in one of the splitter fins being provided with reduced depth over most of its length, an outer edge of T-section, a roughened surface, or longitudinal corrugations. (D.L.C.)

21281 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR GRAPHITE STRUCTURES. Arthur Firth, William Rodwell, and Bernard John Goulding (to United Kingdom Atomic Energy Authority). British Patent 923,905. Apr. 18, 1963. Filed Nov. 26, 1959.

A graphite moderator structure is designed which comprises a mass of elongate graphite blocks of prismatic form arranged end-to-end with the grain running parallel to the axes of the columns. The blocks are spaced apart at their side faces by ceramic tiles disposed along planes perpendicular to the columns. (D.L.C.)

21282 IMPROVEMENTS RELATING TO THE CONTROL OF NUCLEAR REACTORS. John Shaw Hollings and Alan Maurice Jarvis (to United Kingdom Atomic Energy Authority). British Patent 923,921. Apr. 18, 1963. Filed Mar. 1, 1957.

A reactor control system is designed which uses mercury as an absorber medium and which does not contain moving mechanical parts. The control system comprises a plurality of evacuated U-tube systems, each having a first limb within the reactor core and a second limb outside the core. Liquid mercury is retained in the second limbs of the U-tubes by electromagnetic pumps, and on deenergization or failure of the pumps, the liquid mercury flows into the core to stop the reaction. (D.L.C.)

21283 IMPROVEMENTS IN OR RELATING TO NUCLEAR FUEL ELEMENTS. (to Babcock and Wilcox Ltd.). British Patent 923,950. Apr. 18, 1963. Priority date Mar. 22, 1960, Germany.

A fuel element can is described which is suitable for use in a reactor at temperatures above 750°C. The can comprises an inner sheath of silicon dioxide (quartz) and an outer sheath of graphite, the sheaths being separated by a thin layer of silicon carbide. This thin layer may be formed by raising the can to 1475°C for a short time. (D.L.C.)

21284 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTORS. (to Siemens-Schuckertwerke Aktiengesellschaft). British Patent 924,045. Apr. 18, 1963. Priority date May 29, 1958, Germany.

A moderator vessel for liquid-moderated heterogeneous reactors is designed for uniform flow of moderator liquid throughout the vessel. The vessel has guide means for forming a plurality of zones within for inducing uniform flow, and several embodiments of such guide means are described, e.g., nest of guide cylinders, roll of sheet metal, interposed rows of plates, etc. (D.L.C.)

21285 IMPROVEMENTS RELATING TO BURST SLUG DETECTION DEVICES FOR GAS COOLED NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,185,212, addition 75,124. Mar. 13, 1961. Filed Feb. 5, 1959.

For the detection of bursts of fuel element slugs in gas cooled nuclear reactors, means are provided for measuring successively the radioactivity of gas samples coming from the different fuel element channels and comparing the measured values of radioactivity with reference values individual for each reactor channel. These reference values are adjusted at each moment according to the relation of the actual reactor power to an original reactorpower at which the original reference value was determined, these reference values being conserved by electric or electronic storage means. In case said reference values are stored in a digital manner, their adjustment is performed by a digital computer. (IIB)

21286 NUCLEAR FUEL ELEMENT LEAK DETECTION. (to General Electric Co.). French Patent 1,228,525. Aug. 31, 1960. Priority date May 13, 1958, United States.

A process and apparatus for detecting the existence of and for identifying defective and leaking fuel elements in nuclear reactors including the steps of and means for withdrawing a sample of fluid flowing adjacent a given fuel element and containing any noble gas fission products leaking from a defective fuel element, passing at least part of the sample through contact with a body of solid adsorbent to absorb at least part of the radioactive daughter products of the noble gas fission products, and subsequently monitoring the adsorbent to determine the presence thereon of adsorbed radioactive materials. Preferably a sample of coolant stream, which may contain rare or noble gas fission products, is obtained from the exit region of each fuel channel, or groups of fuel channels. Each sample of coolant is then separated into liquid and gas phases, and the gas phase is conducted to an adsorptive collector which may be within the reactor vessel. After reactor shutdown, due to a fuel element leak as may be shown by a high coolant activity rise, or in the normal course of refueling, the collectors are removed to a monitoring station. If anomalously high activity is detected on some collector, it will indicate the channel or group of channels in which a leak has occurred. (IIB)

21287 BURST CARTRIDGE DETECTION EQUIPMENT FOR NUCLEAR REACTORS. (to General Electric Co. Ltd.). French Patent 1,234,694. Oct. 19, 1960. Priority date Sept. 9, 1958, Great Britain.

Experience with the Calder Hall type of nuclear reactor has shown that fuel elements fail in two ways; one is a slow failure which takes place over several hours and the other is a rapid failure in a matter of minutes. This patent relates to a burst cartridge detection equipment for nuclear reactors which is particularly adapted to detect these two types of failure to the greatest economic advantage. This equipment of the kind in which samples of cooling fluid are arranged to be drawn from each of a plurality of fuel element channels of the reactor and monitored, comprises first monitoring means to monitor a group of said channels at one sensitivity, second monitoring means simultaneously to monitor the remainder of said channels at another sensitivity lower than the first, and sequence means to cause the first monitoring means sequentially to monitor all of said channels in groups while the remainder is being monitored by the second monitoring means. (IIB)

21288 MEANS FOR REMOTE-INDICATION, ESPECIALLY APPLICABLE TO THE DETECTION OF BURST SLUGS IN NUCLEAR REACTORS. (to Hawker Siddeley

Nuclear Power Co. Ltd.). French Patent 1,251,623. Dec. 12, 1960. Priority date Mar. 17, 1959, Great Britian.

This patent relates especially to burst slug detection systems in nuclear reactors of the kind in which samples of cooling fluid are drawn from each fuel element channel. The means for providing a remote indication comprises a signal detector associated with each source while the number of indicators is lower than the number of sources. The signal detectors are connected to the indicators in accordance with a matrix considered to be formed by the signal detectors in three or more dimensions, so that if a, b, c are the number of signal detectors in each direction, the total number of detectors is given by abc. The detectors in the same location with respect to each dimension are connected together to an indicator. The number of indicators required for each detector corresponds to the number of dimensions in the equivalent matrix, so that the number of indicators is only a + b + c. (IIB)

21289 NUCLEAR REACTOR. (to United Kingdom Atomic Energy Authority). French Patent 1,254,826. Jan. 16, 1961. Priority date Apr. 27, 1959, Great Britain.

A method of testing the presence of a damaged fuel cartridge in a gas cooled nuclear reactor comprises sampling coolant gas, which has passed over the cartridges in the reactor, precipitating for a minimum period of two minutes any ionised particles present in the coolant gas sampled, and measuring the activity of the precipitated particles. The apparatus for testing the presence of a damaged fuel cartridge according to this method comprises a bank of precipitation chambers, means for moving an electrode therethrough, this electrode passing after the precipitation of the particles from the chambers to a bank of monitors, so that each monitor measures only the activity of ionised particles precipitated from a chamber corresponding to the monitor in question and a signal occurring at a monitor can be identified in this manner with a particular precipitation chamber. A pressure vessel encloses the precipitation chambers, electrode and monitors. Preferably the said electrode is constituted of a wire running over pullies and passing successively the banks of precipitation chambers and of monitors. (IIB)

21290 ASSEMBLAGE OF SOLID MODERATOR WITH A SQUARE LATTICE FOR NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,266,508. June 5, 1961.

The assemblage of the solid moderator for a nuclear reactor consists of a plurality of adjacent vertical columns each column comprising moderator blocks, of large vertical dimension in relation to the square cross section, provided with vertical axial ducts forming the reactor channels. These columns are spaced from each other and are distributed in two coaxial sets, the cross sections of the columns of the central set being smaller than the cross sections of the columns of the marginal set, so that for neutron flux flattening in the center there is a higher fuel concentration than in the periphery region. Each block is, in each column, separated from the following by a parallelepiped moderator element, these elements forming at different levels horizontal beds, while means are provided for connecting adjacent columns at the level of each of said horizontal beds. Preferably these connecting means are constituted of parallelepiped keys engaging in vertical keyways provided in the sidefaces of adjacent elements to be connected. (IIB)

21291 ASSEMBLAGE OF SOLID MODERATOR FOR NUCLEAR REACTORS. (to Commissariat à l'Énergie Atomique). French Patent 1,270,554. July 24, 1961. Filed July 4, 1960.

An assemblage of solid moderator for nuclear reactors comprises a plurality of columns disposed side by side according to a regular lattice. Each column is provided with an axial reactor channel formed by a series of prismatic elements disposed one upon another and having a polygonal external contour. The joining between the columns is effected by keys which are parallel to at least three planes passing through the axis of the columns and which fit into longitudinal keyways provided in the side faces of the elements. Each element is constituted by an assemblage of identical prisms of which one of the longitudinal side faces comprises part of the internal wall of the channel axially traversing the column. Each element, in the same column, is displaced angularly, with respect to both the adjacent elements of the same column in such a way that the contact planes of the prisms of one element are not in alignment with the corresponding contact planes of said adjacent elements. The said external contour of each tubular element may be e.g., a regular hexagon, a square or a flattened hexagon having two axes of symmetry. (IIB)

21292 AUTOMATIC CONTROL SYSTEM FOR NUCLEAR REACTORS. (to United Kingdom Atomic Energy Authority). French Patent 1,273,173. Aug. 28, 1961. Priority date Nov. 9, 1959, Great Britain.

In a nuclear reactor the measured temperature of a fuel element is regulated by controlling the reactor with the aid of a control rod. The servo-system for the control rod comprises a two-phase squirrel cage induction motor and electro-mechanical feedback means for inducing a phase leading for the servo system. The signal representing the measured temperature is compared with a reference signal, the difference signal formed in this manner is converted in an alternating current feeding an amplifier which, in its turn feeds said induction motor. The said electro-mechanical feedback means comprises an synchroneous emitter coupled with said induction motor, and feeding over an induction regulator a second input signal to said amplifier. This second input signal is fed also to a second amplifier feeding a second biphase motor steering said induction regulator. (IIB)

21293 BLOCK ASSEMBLY. (to United Kingdom Atomic Energy Authority). French Patent 1,273,232. Aug. 28, 1961. Priority date Nov. 9, 1959, Great Britain.

A moderator system for a nuclear reactor comprises a plurality of blocks of moderating material. Each block has a large vertical dimension with respect to the square cross section. These blocks are arranged in layers in which the blocks are spaced from each other, while two adjacent layers of blocks are separated by a layer of contiguous plates, so that the moderator system forms a plurality of adjacent columns. Each column consist of a piling of alternating disposition of said blocks and plates and is provided with an axial reactor channel. The horizontal end faces of the plates are provided with circular tenons through which the boring of the reactor channel passes. These tenons fit in corresponding cavities provided in the end faces of the adjacent blocks. The axis of the tenons are eccentric to the channels, opposite tenous of the same plate having opposite eccentricities with respect to the channel axis. Tenons of adjacent plates in the same layer have a shift of eccentricity of 90°. (IIB)

21294 FUEL ELEMENT FOR NUCLEAR REACTORS. John B. Burnham, Jr. (to General Motors Corp.). U. S. Patent 3,085,059. Apr. 9, 1963. Filed Oct. 2, 1958.

A fuel element of the encased ceramic type is designed which has a high thermal conductivity from the fuel through the casing and which is relatively simple to make. The fuel element includes a layer of vitreous material between and bonded to the ceramic fuel pellets and the casing. The requirements for a satisfactory vitreous material are outlined, and several glass compositions are given. The fuel element is made by placing a quantity of glass frit at the bottom of the casing, filling the tube with pellets, heating and pressing the assembly to cause the glass to melt and extrude upwardly between the pellets and the casing, and finally sealing the assembly with a small gas space at the top. (D.L.C.)

21295 NUCLEAR REACTOR SAFETY DEVICE. Charles R. Russell (to General Motors Corp.). U. S. Patent 3,085,060. Apr. 9, 1963. Filed Mar. 2, 1959.

A self-contained, self-actuating safety device is designed which will shut down the reactor upon the occurrence of a predetermined excessively high temperature in the core. The safety device comprises a closed tube partially filled with a mixture of fissionable material and a liquid having a high vapor pressure at a temperature slightly above the desired operating reactor temperature. The fissionable material in the tube forms a part of the reactor critical mass, and the unfilled portion of the tube extends outside the core. In event of core temperature rises, the liquid forces the fissionable material outside the core zone, thereby reducing the reactor power output. (D.L.C.)

21296 NUCLEAR REACTOR FOR HEATING A SUBSURFACE STRATUM. Manley L. Natland (to Richfield Oil Corp.). U. S. Patent 3,085,957. Apr. 16, 1963. Filed Dec. 26, 1957.

A reactor is designed for recovering oil and gas from a subsurface stratum by heating the borehole to temperatures of 400 to 1500°F. The reactor is lowered into position while at a subcritical level and then made critical by the introduction of a liquid moderator into the core. (D.L.C.)

21297 GRAPHITE MODERATOR STRUCTURES FOR NUCLEAR REACTORS. Herbert Chilvers Knights and Peter Neil Munn (to United Kingdom Atomic Energy Authority). U. S. Patent 3,085,958. Apr. 16, 1963. Filed Oct. 31, 1958.

A stack of unspaced graphite blocks is designed which is not unduly distorted under irradiation growth. The side faces of the blocks are recessed along most of their lengths so that contact between the side faces occurs only over narrow contact bands at the block ends. The stack is provided with centripetal restraint means acting at the planes of the contact bands. (D.L.C.)

21298 GIRDLES FOR VERTICALLY STACKED SOLID MODERATOR BARS IN A NUCLEAR REACTOR. Henri Correc (to Commissariat à l'Énergie Atomique). U. S. Patent 3,085,960. Apr. 16, 1963. Priority date June 5, 1958, France.

A girdle for a reactor core is designed so that it is still effective should one of its elements break. The girdle essentially consists of two separate girdles with alternated elements. Several embodiments of the girdle are described. (D.L.C.)

21299 REACTOR ABSORBER ROD AND RETRACTING MECHANISM THEREFROM. Stanley J. Whittaker (to Atomic Energy of Canada Ltd.). U. S. Patent 3,085,962. Apr. 16, 1963. Filed Aug. 21, 1959.

A control rod and retracting mechanism are designed for heavy water reactors. The rod comprises three telescopic sections, and the mechanism uses a lifting tape and a winding drum. (D.L.C.)

21300 NEW METHOD OF CONNECTING SOLID MODERATOR RODS IN AN ATOMIC PILE. Roger Martin (to Commissariat à l'Énergie Atomique). U. S. Patent 3,085,963. Apr. 16, 1963. Priority date Oct. 18, 1958, France.

A stack of hexagonal moderator rods is designed with improved connecting means. The means comprise a plurality of grooves spaced around the rods, a plurality of Y-shaped keys for engaging the grooves, and distance pieces for insertion between the keys for keeping the rods at the desired distances. (D.L.C.)

21301 LIQUID HOMOGENEOUS FUEL ELEMENT AND REACTOR THEREFOR. John W. Flora (to North American Aviation, Inc.). U. S. Patent 3,085,966. Apr. 16, 1963. Filed Nov. 8, 1960.

A fuel element-reactor combination is described which combines the advantages of heterogeneous and homogeneous reactors. The fuel elements contain a solution of enriched UO_2SO_4 and are arranged in heterogeneous arrays. Each fuel element comprises a container, an extension welded to the bottom for supporting the element on a grid in the reactor, a liquid volume with an internal chimney for promoting fuel circulation, baffle means for separating radiolytic gases from the fuel, and an upper volume for recombining the radiolytic gases. (D.L.C.)

Power Reactors

Refer also to abstract 20419.

21302 (ACNP-61517) HAZARDS ANALYSIS. EFFECTS OF STEAM GENERATOR TUBE RUPTURE. Andre H. Gage (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 1, 1960. Contract [AT(10-1)-925]. 40p. (EGCR-STUDY-IV-316(Rev.1))

A review of the basis for sizing the EGCR coolant system relief valves is presented. The possible effects of steam-graphite reaction in event of a boiler tube failure are also considered along with hazards of steam generator water side depressurization. (J.R.D.)

21303 (ACNP-61529) HAZARDS ANALYSIS. MINOR HAZARDS. D. Luse and R. S. Miller (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 17, 1961. Contract [AT(10-1)-925]. 17p. (EGCR-STUDY-IV-323(Rev.3))

An evaluation of the minor hazards associated with operation of the Experimental Gas Cooled Reactor is presented. (J.R.D.)

21304 (ACNP-61534) INADVERTENT OPERATION COOLANT LOOP ISOLATION VALVES. HAZARDS ANALYSIS. A. DeAgazio (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 28, 1961. Contract [AT(10-1)-925]. 39p. (EGCR-STUDY-IV-320 (Rev.2))

Results of a study to determine if a hazardous condition is created by accidental closing of the coolant loop isolation valves while the reactor is operating are presented. (J.R.D.)

21305 (ACNP-61543) LOSS-OF-PRESSURE ACCIDENT. HOT LEG PIPING FAILURE. A. W. De Agazio (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Jan. 11, 1962. Contract [AT(10-1)-925]. 11p. (EGCR-STUDY-IV-303-4(Rev.1))

Results are presented of a study to determine if a circumferential rupture in the EGCR hot-leg piping just downstream of the block valve, accompanied by complete lateral displacement of the pipe ends such that the exhaust flows

do not oppose each other, will result in excessive pressure differentials across the reactor core. Conclusions and recommendations are included. (J.R.D.)

21306 (ACNP-62600) FAILURE OF THE FUEL-LATCHING MECHANISM. J. A. Landoni (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 9, 1960. Contract AT(10-1)-925. 27p. (EGCR-STUDY-IV-305(Rev.2))

A study was conducted to evaluate the hazards resulting from failure of the EGCR bottom dummy fuel assembly latching mechanism. It was concluded that such a failure will not create any undue hazards to the reactor or personnel. (J.R.D.)

21307 (ACNP-62607) HAZARDS ANALYSIS SINGLE BLOWER FAILURE. D. A. Lampe (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 23, 1960. Revised Jan. 15, 1963. Contract AT(10-1)-925. 16p. (EGCR-Study-IV-322(Rev.2)).

A study was made to determine reactor coolant outlet temperature and the number of fuel element failures which will occur in the event that one of the two reactor coolant system blowers de-blade. It was concluded the maximum coolant outlet temperature from the average power fuel channel during the accident is 1178°F. The upper plenum coolant temperature will be less since the gas bypassing the reactor core will enter the upper plenum at temperatures below 1000°F. A plot of fuel channel exit temperature and estimated upper plenum coolant temperature during the accident is presented. The maximum predicted number of fuel element failures are listed. (auth)

21308 (ACNP-63508) LOSS-OF-PRESSURE ACCIDENT—HOT LEG PIPING FAILURE (BLOWER BEHAVIOR CONSIDERED). J. A. Landoni (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Jan. 11, 1960. Revised Dec. 20, 1962. Contract [AT(10-1)-925]. 40p. (EGCR-Study IV-303-1(Rev.1))

A study was made to determine pressure differentials across coolant system components by considering the blowers' influence during the transient state following a rupture in one hot leg of the Experimental Gas Cooled Reactor Coolant System. Results are presented in tables and graphs. It was concluded that a large instantaneous rupture of the reactor coolant system results in lifting the core when the entire graphite area is exposed to the differential. The forces depend on the type of gas seal used to prevent bypass of reactor coolant around the graphite columns. If the gas seal is located at the periphery of the column, the entire graphite area is subjected to the pressure differential. The use of a separate gas seal at each fuel channel results in only a portion of the graphite column cross-sectional area exposed to the pressure differential thereby reducing the upward force on the core graphite. The incorporation of "quick-closing" valves in the reactor coolant system also reduces the differential pressure across the core and limits the lifting force to which the core is subjected. (M.C.G.)

21309 (ACNP-63511) VESSEL COOLING SYSTEM AND TEMPERATURE BARRIER FAILURE HAZARDS ANALYSIS. D. A. Lampe (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Mar. 17, 1961. Contract AT(10-1)-925. 51p. (EGCR-STUDY-IV-304 (Rev.1))

A study was conducted to evaluate the hazardous consequences of EGCR vessel cooling system and vessel temperature barrier failures. Conclusions and recommendations concerning these hazards are included. (J.R.D.)

21310 (AMF-388-TR-3) AMF ON-POWER REFUELING SYSTEM FOR A CANDU-TYPE REACTOR. ADAPTER VALVE DEVELOPMENT REPORT. (AMF Atomics. Div. of American Machine and Foundry Co., Greenwich, Conn.). Feb. 1963. Contract AT(38-1)-233. 188p.

Development of the reference adapter valve for the alternate on-power refueling machine head used in connection with CANDU-type power reactors is described. Results of valve component testing are included. (J.R.D.)

21311 (ANL-6411) SAFETY ANALYSIS REPORT, EBR-I, MARK IV. R. O. Haroldsen, F. D. McGinnis, M. Novick, R. R. Smith, and F. W. Thalgott (Argonne National Lab., Idaho Falls, Idaho). Feb. 1963. Contract W-31-109-eng-38. 153p.

Operation of the Mark IV Core, fueled entirely with metallic Pu, introduces a variety of problems which must be scrutinized prior to full power operation. These hazards along with other potential hazards shared in common with conventional U loadings are examined. The pertinent features of the reactor and its supporting plant are also reviewed. (J.R.D.)

21312 (DLCS-5000263) MONTHLY OPERATING REPORT [ON PWR OPERATION], FEBRUARY 1963. (Duquesne Light Co., Shippingport, Penna.). Contract AT (11-1)-292. 50p.

A gross generated output of 68 Mw was maintained for the first four days of February, after which the Station was shutdown for the Xe Transient Test, which was terminated February 6. Further testing was performed at power for the next three days, with the exception of a period of approximately 18 hrs when the Station was shutdown and the reactor coolant pressure was reduced for the performance of electrical checks in the reactor chamber. The Station resumed full power operation February 8 and operated at a gross electrical output of 68 Mw until February 24, when the Station was shutdown for maintenance work and testing. The reactor was again taken critical February 27 for power operation. At the end of this report period the Station was maintaining a 68 Mw gross electrical output. Specified water conditions were maintained in the RCS and the Reactor Plant auxiliary systems throughout the month. The general level of Seed 4 fission product activity has shown a small decrease from steady state levels observed at the end of Seed 3 lifetime. The peaking of fission products I_2 and Cs activities was again observed during power transients, indicating the presence of one or more failed blanket assemblies in the core. Maintaining boiler water specifications was difficult during the month because of the various power transients. However, chemical treatment was effective in restoring water specifications. Conditions related to personnel radiation exposures and radioactive contamination were normal throughout the month. As of the end of the report period there were five tests in progress, with ten tests having been completed during the month. Fourteen test procedures, two test evaluations, and 19 preliminary reports were also prepared and issued in February. (auth)

21313 (GAMD-2970(and Add.1,2,&3)) TRANSIENT ANALYSIS OF THE MGCR PLANT. T. M. Silks (General Dynamics Corp. Electric Boat Div., Groton, Conn.). May 1960. Contract AT(04-3)-187. 177p.

The derivations of the equations used in a transient analysis of the marine gas cooled reactor (MGCR) plant are presented, and the format for their solution by digital computer is shown. The system under consideration includes the control systems for the power turbine bypass valve, the control rods, and the accumulator valves. (auth)

21314 (GEAP-4146) EVESR-NUCLEAR SUPERHEAT FUEL DEVELOPMENT PROJECT SECOND QUARTERLY REPORT, SEPTEMBER–NOVEMBER 1962. R. T. Pennington (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Dec. 1962. Contract AT(04-3)-189. 69p.

Program activity during the period was primarily in the areas of planning, design, and fuel fabrication. Plans concerning fuel development are outlined along with those concerning cladding development and reactor research and development. The EVESR was scheduled to go critical in February 1963. (J.R.D.)

21315 (GEAP-4162) DEVELOPMENT OF PULSED NEUTRON APPLICATION TO POWER REACTOR START-UP PROCEDURES. Third Quarterly Progress Report, October 1–December 31, 1962. Edward Garelis and Paul Meyer (General Electric Co. Atomic Power Equipment Dept., San Jose, Calif.). Jan. 7, 1963. Contract AT(04-3)-189. 8p.

Validity of the one-velocity diffusion theory assumption used in developing a theoretical method for the determination of the reactivity in dollars of a repetitively pulsed subcritical assembly was examined. Tests of the theoretical model were performed at the Critical Experiment Facility, and surface barrier detectors using U^{235} were examined for their gamma and neutron sensitivity. Testing of a very fast neutron detector was begun, and electronic components of the K-1 Elliott neutron generators were completed and tested satisfactorily. (D.C.W.)

21316 (IDO-28597) ARMY GAS-COOLED REACTOR SYSTEMS PROGRAM. STUDY OF THE GCRE TUBE BUNDLE FAILURE. (Aerojet-General Nucleonics, San Ramon, Calif.). Dec. 1962. Includes Appendix: FAILURE ANALYSIS OF GCRE BOLT AND SCUFF PLATE. P. F. Young. Contract AT(10-1)-880. 55p.

The failure of the tube bundle section of the GCRE-I reactor, a test reactor associated with the ML-1 development program, is discussed. The history of the fabrication, testing, and operation of the tube bundle is reviewed as well as the post-failure examination and metallurgical investigations. It was concluded that the failures occurred as a result of loss-of-coolant flow and subsequent boiling, which initiated complex corrosion processes in highly stressed areas of the pressure tubes in the region of the upper tube sheet coolant passages. (auth)

21317 (KAPL-2217) THE SPACE-TIME NEUTRON KINETICS BY A VARIATIONAL METHOD WITH APPLICATION TO POWER REACTOR DYNAMICS. D. E. Dougherty (Knolls Atomic Power Lab., Schenectady, N. Y.). Dec. 26, 1962. Contract W-31-109-eng-52. 57p.

By use of the semidirect variational method, the time and space dependent neutron kinetic equations were reduced to a system of integro-differential equations in the time domain. The state vector of these equations defines the time-dependent coefficients for a set of space modes given by a modal expansion of the neutron flux. The accuracy of this method of analysis is arbitrary, and solutions are available for reactor configurations as complex as the present state of the art allows steady-state determinations. To avoid the difficult task of determining orthogonal eigenfunctions for a modal expansion in a complex geometry, nonorthogonal Green's Function modes are developed from an approximate solution of the integral form of the multigroup kinetic equations. Since an exact steady-state solution of the one-group diffusion model is available for a bare two-region slab reactor, this solution was compared with the results obtained by both orthogonal and nonorthogonal modal expansions. The basis of comparison was the asymptotic region buckling for a critical (steady-state) two-region reactor, following a perturbation of the reactor material properties in either of the core regions. A two-term expansion by Green's Function modes was clearly superior to an expansion in which the first two orthogonal modes for asymmetric perturbations of the core properties were used. Combining power coefficient dynamics with the reduced space-dependent neutron kinetic equations yields a state equation that is in general nonlinear. By linearizing these equations and using the transfer function formalism, the transformed equation of state for the modal coefficients for a generalized power coefficient is obtained. Illustrative calculations were made for a simple second-order temperature and xenon poisoning power coefficient. A stability criterion was derived for the spatial flux distribution of an annular core model. Reasonably good agreement was obtained between the calculated stability margin and period of the spatial flux oscillations observed in the Shippingport Pressurized Water Reactor. Also calculated was the response of the spatial flux distribution in an annular core to both step and harmonic reactivity changes. 34 references. (auth)

21318 (NAA-SR-Memo-3556 and Add.) ANALYSIS OF THE HEAT GENERATION IN THE PRIMARY SODIUM PIPE TUNNELS, INTERMEDIATE HEAT EXCHANGER CELLS, AND THE PRIMARY SODIUM FILL TANK VAULT FOR THE HALLAM NUCLEAR POWER FACILITY (HNPF). P. J. Legendre (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). Mar. 27, 1959. Includes Addendum. Apr. 25, 1959. Contract [AT-11-1-GEN-8]. 48p.

I. An adequate and conservative calculational method for evaluation of the heat generation distribution in the primary sodium system substructural areas was developed. The method was programed for the IBM 704 and the IBM 709. The results obtained from analysis of the gamma heat generation in the primary sodium pipe tunnels and in the intermediate heat exchanger cells are presented. Calculations are outlined, and γ attenuation coefficients for concrete, sodium, and steel are given. II. Results obtained from analysis of the gamma heat generation in areas where the primary sodium system piping layout was changed from that of the previous analysis are presented. Major changes in magnitude of the hot spot heat generation due to the changes are pointed out. (auth)

21319 (TID-18467) SAVANNAH NUCLEAR POWER REACTOR OPERATIONS AT YORKTOWN. Summary Test Report. (New York Shipbuilding Corp., Camden, N. J.). May 11, 1962. 56p. (NSS-112)

A summary of Savannah test program through Phase V is presented. Other reports containing information related to this program include NSS-104 (Summary Test Report, Phases I and II) and NSS-106 (Summary Test Report, Reactor Operations at Camden). (J.R.D.)

21320 (TID-18528) HAZARDS ANALYSIS. DEPRESSURIZATION ACCIDENT. D. A. Lampe (Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Nov. 18, 1960. Contract [AT(10-1)-925]. 62p. (EGCR-STUDY-IV-312)

Results of a study to determine the number of EGCR fuel element failures during and following depressurization accidents are presented. Core cooling with 18-psia air or He is evaluated. The effects of graphite oxidation are considered. (J.R.D.)

21321 (TID-18529) HAZARDS ANALYSIS. INADVERTENT OPENING OF BYPASS VALVES. D. A. Lampe

(Allis-Chalmers Mfg. Co. Atomic Energy Div., Washington, D. C.). Oct. 26, 1960. Contract [AT(10-1)-925]. 44p. (EGCR-STUDY-IV-314)

A study was conducted to determine the hazards resulting from opening the EGCR coolant system bypass valves during normal reactor operation. It was found that this valve may be inadvertently opened by electrical or mechanical failure. Installation of a flow element located so that such signals will scram the reactor is recommended. (J.R.D.)

21322 (WAPD-T-1496) MEASURING POWER DISTRIBUTIONS IN PWR. J. H. Leonard (Westinghouse Electric Corp. Bettis Atomic Power Lab., Pittsburgh). June 1962. Contract AT-11-1-GEN-14. 21p.

PWR incorporates thermocouples measuring exit coolant temperature and flow measuring devices to monitor core power distributions rather than using a neutron flux scanning system. Experience has shown that the thermocouples require periodic calibration to maintain the required accuracy. The data obtained thus far from the instrumentation have generally confirmed calculated power distributions. Thus, the determination of core thermal capability is based on calculated power distributions with small corrections based on accumulated thermocouple measurements which result in a conservative evaluation of core performance. However, considerations regarding the interpretation of exit coolant temperature readings in terms of average power output per cluster make it desirable to provide means of obtaining more refined local power data. Grouped thermocouples will be installed in selected seed locations to provide improved data so that more quantitative verification of calculational techniques can be obtained. The continuance of the comprehensive instrumentation program for future PWR operations will provide additional experience which will contribute to the development of core instrumentation systems to assess the thermal performance characteristics of power reactors relative to calculations accurately and continuously. (auth)

21323 THE HOMOGENEOUS SUSPENSION REACTOR PROJECT. J. J. Went. Atoomenergie Haar Toepassingen, 5: 25-31(Feb. 1963). (In Dutch)

The considerations which led to the study of a homogeneous suspension reactor are reviewed briefly. The characteristics of the KEMA Suspension Test Reactor (KSTR) are then summarized. (J.S.R.)

21324 BELOYARSK ATOMIC POWER PLANT. Energietechnik, 13: 21(Jan. 1963).

The assembly of reactor equipment at the Beloyarsk Atomic Power Plant, located in the Urals, is near completion. The reactor is housed in a 17-story reinforced-concrete building, which also contains 2500 temperature-measuring devices, 500 high-pressure gages, and other apparatus and electronic devices required for remote control of the reactor. The first 100-Mw turbine is also being erected. A reservoir measuring 50 km^2 will supply the power plant with water. (OTS)

21325 PROSPECTS FOR HEAVY-WATER REACTORS. FIRST PART. J. S. Foster. Europa Nucl., 5: No. 6, 29-34 (Nov.-Dec. 1962). (In English)

The problems associated with the economic development of heavy-water reactors are briefly reviewed as an introduction to a discussion of the nuclear power prospects of the world. An estimate is made of the world nuclear plant capacities at the present time and in 1972. Reactor types that will offer competition to the heavy-water reactors are indicated. (J.S.R.)

21326 PROBLEMS OF MERCHANT SHIP NUCLEAR PROPULSION. B. Hildrew. Trans. Inst. Marine Engrs., 74: 501-20(Oct. 1962).

The fact that all marine reactor installations proposed to date are totally uneconomical is discussed. In addition, the apparent savings in relation to new reactor designs disappear when a project is required to conform to the accepted conservative design criteria and construction codes for marine nuclear work. Accordingly the major engineering and ship items that are amenable to modification and cost reduction without impairment to the reliability required of a marine installation are examined. Suitable reactor types already proven on land, together with those being developed or capable of development as marine reactors within the present decade, are briefly examined in relation to the proposed design variations, and the potential of each reactor in a marine installation is discussed. It is concluded that parity with conventional marine engines will ultimately be achieved, but for any chosen reactor type considerable financial outlay on development and proving a land-based prototype installation will be necessary. (auth)

21327 ELECTRICAL DESIGN CONSIDERATIONS FOR CLOSED CYCLE WATER REACTORS. D. C. Beatty (Westinghouse Electric Corp., Pittsburgh). IEEE Preprint Paper No. CP-63-370. 10p.

The Closed Cycle Water Nuclear Power Plant has certain intrinsic characteristics that the electrical designer must recognize and must provide with appropriate systems. A number of electrical systems in the plant must be provided with dual service and with components operating in parallel to assure plant reliability by avoiding shutdowns due to possible malfunction of a single item. The electrical systems that receive special consideration are discussed. (C.E.S.)

21328 ADVANCED GAS-COOLED REACTORS—AN ASSESSMENT. R. V. Moore and J. D. Thorn (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Preprint Paper No. 1. London, British Nuclear Energy Society, 1963. 15p.

Paper from Symposium, Mar. 1963.

The Advance Gas-cooled Reactor (AGR) is thoroughly evaluated in terms of its reference design, moderator design, safety, economic performance, and development potential. A description and design approach are given for the fuel elements. Capital cost of a reactor plant are considered from the point of view of reactor size. The fuel cycle and plutonium utilization are described. Parameters for reference design and design scale drawings are included. (C.E.S.)

21329 THE GENERAL DESIGN OF THE EXPERIMENTAL ADVANCED GAS-COOLED REACTOR. S. Fawcett and G. Brown (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Preprint Paper No. 2. London, British Nuclear Energy Society, 1963. 14p.

Paper from Symposium, Mar. 1963.

The main features of the advanced gas-cooled reactor and the reasons for major design decisions are summarized. It is shown how the design was controlled by the experimental requirements. (C.E.S.)

21330 CIVIL ENGINEERING AND PLANT LAYOUT. F. G. Johnson (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), J. R. Gleave, and J. B. L. Faulkner. Preprint Paper No. 3. London, British Nuclear Energy Society, 1963. 11p.

Paper from Symposium, Mar. 1963.

The AGR, Windscale is a fully contained, gas cooled, power reactor. The entire reactor is housed within a "pear-shaped," steel containment building of 135 ft maximum diameter, founded on a dished reinforced concrete raft. The whole of the primary coolant circuit is shielded and contained within concrete vaults that form an inner

containment. The more interesting features of the civil engineering and plant layout are described, and details of the structural design and construction are given. (auth)

21331 THE CONTAINMENT BUILDING FOR THE ADVANCED GAS-COOLED REACTOR, WINDSCALE. N. T. Barrett (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), J. J. Haftke, and W. J. M. Davies. Preprint Paper No. 4. London, British Nuclear Energy Society, 1963. 10p.

Paper from Symposium, Mar. 1963.

The containment building must not only carry the pressure and temperature loads imposed upon it but also provide all the normal functional requirements of a building. To minimize the conflicts that arise between these two major functions, the internal structure was designed to be self-supporting so that the containment shell is free-standing and only restrained at its base. (auth)

21332 THE DESIGN OF THE PRESSURE CIRCUIT. A. Firth (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). D. J. Dawson, R. W. Horseman, and L. Warren. Preprint Paper No. 5. London, British Nuclear Energy Society, 1963. 18p.

Paper from Symposium, Mar. 1963.

The design implications of a single channel access, reentrant flow circuit, and the co-planar support system for the reactor vessel and heat exchangers are considered. The detailed design of the pressure circuit components are given. (C.E.S.)

21333 MAIN CIRCULATORS. J. D. Thorn (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), W. M. Fraser, E. Long, and K. K. Schwarz. Preprint Paper No. 6. London, British Nuclear Energy Society, 1963. 8p.

Paper from Symposium, Mar. 1963.

Careful appraisal of the design principles for the main circulators of the advanced gas cooled reactor is given. The effects of dealing with a coolant that could possibly be toxic and the implications of being situated in an occupied containment building were considered. These considerations emphasized the need to prevent gas leakage under all circumstances and to provide a very compact design that could accept attachment to a heat exchanger that moved due to thermal expansion of the ducts and other parts. (C.E.S.)

21334 DESIGN OF THE REACTOR INTERNALS AND FUEL HANDLING. P. Waine (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), W. Rodwell, and D. R. C. Guttery. Preprint Paper No. 7. London, British Nuclear Energy Society, 1963. 17p.

Paper from Symposium, Mar. 1963.

The main functions of the Windscale Advanced Gas-cooled Reactor include the determination of the behavior of the graphite moderator and the provision of statistical information on the performance of fuel suitable for a commercial reactor. These functions have had considerable influence on the integrated design of equipment within the reactor vessel including the core, of the fuel element stringer, and of the refuelling arrangements. Individual channel refueling enables reliable instrumentation of fuel assemblies and coolant to be achieved and provides a procedure that obviates grappling in the core. A further consideration in design was in the access afforded for erection of internal components. Storage of irradiated fuel in dry CO_2 during decay of fission product heat reduces temperature cycling and obviates corrosion problems that would be severe in water. (C.E.S.)

21335 FUEL ELEMENTS. G. Brown (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), G. Packman, and G. B. Greenough. Preprint Paper No. 8. London, British Nuclear Energy Society, 1963. 11p.

Paper from Symposium, Mar. 1963.

The fuel element is described and discussed in relation to up-to-date information. For evaluation of design an extensive series of tests were applied to determine whether endurance was likely to be adequate. Endurance in fuel elements covers the long term effects of vibration, rattling, and creep deformation. Future developments are also outlined. (C.E.S.)

21336 CONTROL AND INSTRUMENTATION. R. H. Campbell (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.), T. Ormerod, D. Taylor, and P. Murdoch. Preprint Paper No. 9. London, British Nuclear Energy Society, 1963. 8p.

Paper from Symposium, Mar. 1963.

In an experimental reactor installation such as the Windscale AGR, the role of the heat removal plant is of a subsidiary nature since it is provided only as a flexible facility for safe removal of heat. The instrumentation and control of this part of the plant are conventional and are not discussed. Only those aspects appertaining to the reactor are considered. (auth)

21337 PLANT START-UP AND PERFORMANCE. T. N. Marsham, A. Firth, and A. D. Evans (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Preprint Paper No. 10. London, British Nuclear Energy Society, 1963. 20p.

Paper from Symposium, Mar. 1963.

The more significant events in the commissioning of the Windscale AGR are discussed, particularly where these deviated from previous practice. The performance of certain plant items on which experience was gained during the first period of power operation are described from an operational viewpoint. (C.E.S.)

21338 COMMISSIONING MEASUREMENTS AND REACTOR UTILIZATION. J. Moore and R. R. Gallie (United Kingdom Atomic Energy Authority, Windscale, Sellafield, Cumb., Eng.). Preprint Paper No. 11. London, British Nuclear Energy Society, 1963. 11p.

Paper from Symposium, Mar. 1963.

Because of the complex core it was necessary to make an extensive series of reactor physics measurements to develop methods for calculating reactivity and flux distribution and so obtain a satisfactory core loading pattern as quickly as possible during commissioning. The main measurements made in APEX, HERO, and AGR are described. Commissioning measurements on the main reactor circuit and on the four loop tubes including special instrumentation are described. The main measurements to be made and the planned utilization of the reactor during the first two years operation are also considered. Analysis of data obtained during commissioning at zero power is not yet complete, but where possible the available results are quoted. (C.E.S.)

21339 AGR RESEARCH AND DEVELOPMENT PROGRAMME. H. Kronberger (United Kingdom Atomic Energy Authority, Harwell, Berks, Eng.). Preprint Paper No. 12. London, British Nuclear Energy Society, 1963. 4p.

Paper from Symposium, Mar. 1963.

The general aspects of the AGR research and development program are considered. The reactor has two important purposes: to establish confidence in the reliable and economic working of the reactor system, and to pro-

vide a test facility for the rapid exploitation of the development potential of the AGR. The development program was planned with the objective of enabling industry to proceed to a large commercial station in the shortest possible time, and for this purpose the Windscale AGR with its experimental facilities was set up along with a considerable amount of associated plant for the development and testing of fuel and for the study of the physics of AGR's. (C.E.S.)

21340 LOOP SYSTEMS. S. Rigg (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.), A. Duffield, H. A. Martin, and D. R. Smith. Preprint Paper No. 13. London, British Nuclear Energy Society, 1963. 7p.

Paper from Symposium, Mar. 1963.

Experimental loop systems with irradiation space in the core, but physically isolated from it, provide valuable experimental facilities in which materials can be irradiated in other than reactor conditions. In such experimental loops it is possible to alter fuel element temperatures, coolant temperatures, coolant composition, and heat output without appreciably affecting the chosen operating conditions of the reactor itself. In addition, isolated experimental loops can be used for the irradiation of fuel elements that were deliberately made defective without the spread of radioactivity that would interfere with the operation of the reactor burst can detection equipment. (C.E.S.)

21341 METALLURGY OF FUEL AND CANS. H. K. Hardy (United Kingdom Atomic Energy Authority, Springfields, Lancs, Eng.), L. M. Wyatt, and S. F. Pugh. Preprint Paper No. 14. London, British Nuclear Energy Society, 1963. 10p.

Paper from Symposium, Mar. 1963.

Fabrication of the UO_2 fuel and the beryllium and steel canning materials for the Windscale AGR Mk 1 and Mk 2 fuel elements is described. In addition, the present state of knowledge of the in-pile behavior of these materials is reviewed. The materials problems associated with the graphite fuel sleeves, which are similar to those of the bulk moderator, investigations of the chemical interactions of fuel and can, the oxidation and carburization of the fuel by the coolant gas or by air, and problems relevant to the fabrication and design of the complete fuel element are described in other papers to this Symposium. The objective for the Windscale AGR was to develop materials for conservatively-designed fuel elements that would achieve at least 6000 Mwday/ton average irradiation and provide a basis for use in more advanced designs and under more severe operating conditions. (auth)

21342 COMPATIBILITY PROBLEMS IN AGR SYSTEMS. C. Tyzack (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.), C. S. Campbell, and F. W. Trowse. Preprint Paper No. 15. London, British Nuclear Energy Society, 1963. 7p.

Paper from Symposium, Mar. 1963.

The current situation on the compatibility of materials used in the Windscale AGR is briefly surveyed with the exception of the moderator, which is discussed in a separate paper. (C.E.S.)

21343 CORE PHYSICS AND KINETIC STUDIES. F. W. Fenning and F. W. Hutber (United Kingdom Atomic Energy Authority, Risley, Lancs, Eng.). Preprint Paper No. 16. London, British Nuclear Energy Society, 1963. 5p.

Paper from Symposium, Mar. 1963.

The physics and kinetics work carried out for the Windscale AGR was aimed at covering both beryllium and steel canning materials. This meant that complex geometries had to be studied over a range of enrichments from 1 to 3% U^{235}. In addition, the kinetic behavior of the reactor with a strongly moderating can was studied in relation to the neutron flux stability and the control system required when scaled up to large power station size. The general headings under which the physics problems will be discussed are: initial reactivity, distribution of heat production, effect of high burn-up, effect of non-standard channels, temperature effects, core kinetics, fuel cycles, and flattening. The solutions given are as of September 1962. (auth)

21344 EXPERIMENTAL PHYSICS. G. H. Kinchin (United Kingdom Atomic Energy Authority, Winfrith, Eng.), J. Moore, and I. A. Mossop. Preprint Paper No. 17. London, British Nuclear Energy Society, 1963. 10p.

Paper from Symposium, Mar. 1963.

A review of the experimental reactor physics work carried out on AGR systems is given. The aim of the work is to provide information for, or to check, methods of calculation by investigating various components such as leakage, thermal utilization, and fast fission, by the bucklings of uniform lattices, and by the effects of non-uniform lattices. Details of fuel and moderator arrangements used in the fine structure and APEX experiments are described. (C.E.S.)

21345 FUEL ELEMENT HEAT TRANSFER. V. Walker and A. C. Rapier (United Kingdom Atomic Energy Authority, Windscale, Sellafield, Cumb., Eng.). Preprint Paper No. 18. London, British Nuclear Energy Society, 1963. 8p.

Paper from Symposium, Mar. 1963.

In formulating an experimental heat transfer program for rod cluster fuel elements it is important to adopt a fresh approach and not just to carry over methods previously developed. The program for the AGR has therefore consisted of relatively simple experiments on single passages and on small groups of passages to study interactions, with final measurements on a heated model of the rod cluster design to verify the method of fitting together the single passage data. The heated cluster experiment has covered a much wider range of heat flux distributions than the reactor imposes in order to provide a severe test of the correctness of the approach. (C.E.S.)

21346 IRRADIATION BEHAVIOUR OF GRAPHITE. P. T. Nettley (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.), H. Bridge, and J. H. W. Simmons. Preprint Paper No. 19. London, British Nuclear Energy Society, 1963. 11p.

Paper from Symposium, Mar. 1963.

The effects of the atomic displacements produced in graphite by the collision of fast neutrons are of great importance in the technology of graphite-moderated nuclear power reactors. Experimental and theoretical work are outlined on the physical property changes, of interest to reactor designers, associated with these displacements. Various experiments were made and theoretical and empirical procedures developed, which enable results to be correlated over a range of conditions and also enable present data to be extrapolated to much higher doses. It is shown how the rate of release of stored energy, thermal conductivity, dimensional changes, and coefficients of thermal expansion can be estimated for practical values of temperature and irradiation dose in an AGR. Available data on the effect of radiation on the mechanical proper-

ties of graphite are also discussed and the problem of differential stress generation in graphite blocks, due to differential growth and shrinkage is outlined. The graphite in an AGR can be improved to obtain an economic gain and to reduce the deleterious effects of irradiation. The program of work proposed in the future is outlined. This program should, during the next two years, fill in most of the gaps in present knowledge and should enable one to make an extremely reliable estimate of the graphite behavior in an AGR throughout a lifetime of 30 years. (auth)

21347 GAS REACTIONS WITH GRAPHITE IN THE AGR. R. Lind (United Kingdom Atomic Energy Authority, Culcheth, Lancs, Eng.), and J. Wright. Preprint Paper No. 20. London, British Nuclear Energy Society, 1963. 9p.

Paper from Symposium, Mar. 1963.

Graphite specimens were reacted with CO_2 under conditions ranging from small quartz bulbs through more massive in-pile rigs and loops to the exposure to the CO_2 coolant of working reactors. The rates of interaction were followed by various methods including carbon monoxide production, carbon-14 release from labeled graphites, weight losses, and, in instances of extreme attack, by changes in mechanical strength. The studies have tended to concentrate on conditions of direct application to the AGR system, viz.: 300–400°C, 15 to 50 atm pressure, and degrees of attack equivalent to the removal of several monolayers of carbon. (C.E.S.)

21348 IMPROVEMENTS IN OR RELATING TO NUCLEAR REACTOR INSTALLATIONS. Richard Valentine Moore and Gordon Brown (to United Kingdom Atomic Energy Authority). British Patent 922,221. Mar. 17, 1963. Filed Aug. 12, 1958.

A graphite-moderated, gas-cooled reactor installation is designed for experimental studies into improved design of reactors of this type. The features of the reactor include flexibility of coolant circuit control, loop experiments, replacement of moderator, etc. The reactor is designed for 100 Mw(th) and 28 Mw(e) output. (D.L.C.)

21349 NUCLEAR REACTOR. (to Brown, Boveri & Cie A. G. and Beteiligungs-und Patentverwaltungs–Gesellschaft mit Beschraenkter Haftung). British Patent 922,324. Mar. 27, 1963. Priority date Oct. 29, 1960, Germany.

A boiling reactor is designed for the production of superheated steam. In this reactor, only part of the fuel is immersed in the liquid, while the fuel disposed above the liquid is used for superheating the steam. Several embodiments of the reactor with different forms of moderator in the upper space are described. (D.L.C.)

21350 ORGANIC MODERATOR AND/OR COOLANT OF NUCLEAR REACTORS AS SUPPLEMENTAL ENERGY SOURCE. (to Esso Research and Engineering Co.). British Patent 923,356. Apr. 10, 1963. Priority date Dec. 29, 1960, United States.

A method of using hydrocarbons as reactor coolant-moderators is given which overcomes the disadvantages of low heat capacity and temperature limits. In this method, the coolant-moderator is passed through the reactor on a one-through basis, and both its thermal energy and heat of combustion are used to heat water. The characteristics of petroleum fractions which may be used in this manner are tabulated. (D.L.C.)

21351 IMPROVEMENTS RELATING TO NUCLEAR POWER PLANTS. Pierre Maldague. British Patent 923,894. Apr. 18, 1963. Priority date Aug. 4, 1958, Luxemburg.

A nuclear power station is designed for increased additional evaporation capacity. A fossil fuel-fired superheater is provided which can superheat steam in excess of the present steam capacity of the nuclear steam generator, in order to allow for an increase in output from the generator. Additional steam is also generated in the superheater by spraying atomized water into the passing steam. (D.L.C.)

21352 METHOD AND APPARATUS FOR GENERATING AND SUPERHEATING STEAM FROM NUCLEAR ENERGY. Robert L. Whitelaw (to Babcock and Wilcox Co.). U. S. Patent 3,085,056. Apr. 9, 1963. Filed Nov. 30, 1955.

An improved breeder-converter reactor is designed in which the breeding blanket is cooled by superheated steam. The core may comprise either a body of aqueous fuel solution or an assembly of fuel elements, and the blanket comprises a plurality of solid fertile assemblies mounted for rotation about their major axes in a chamber surrounding the core. (D.L.C.)

21353 LIQUID MODERATED VAPOR SUPERHEAT REACTOR. John Halbert Germer (to General Electric Co.). U. S. Patent 3,085,959. Apr. 16, 1963. Filed Jan. 2, 1959.

A liquid-moderated, steam-cooled reactor is designed in which thermal stresses are eliminated in the core support structures. The steam is passed into the reactor at the same temperature as that of the moderator and is caused to follow a helical flow path around the fuel element. (D.L.C.)

21354 MEANS FOR DETECTING INSULATION FAILURE IN REACTOR PRESSURE TUBES. Donald H. Charlesworth (to Atomic Energy of Canada Ltd.). U. S. Patent 3,085,961. Apr. 16, 1963. Filed May 29, 1959.

A pressure tube providing a coolant channel in a power reactor is designed with means for detecting failure of its thermal insulation. The insulation comprises stagnant coolant in dimpled metal sheets between a liner and the tube, and a vent is formed between the upstream end of the insulation and the channel. A ring dividing the insulation into two sections is provided with a small aperture, and a thermocouple is located in the tube in vicinity of the aperture in order to detect temperature rises due to hot coolant penetrating the insulation. (D.L.C.)

21355 NUCLEAR REACTORS. Hugo Heinrich Ludolf Ritz, Manfred Otto Engel, and Barrington Forster (to C. A. Parsons and Co. Ltd.). U. S. Patent 3,085,964. Apr. 16, 1963. Priority date Nov. 7, 1958, Great Britain.

A steam-cooled reactor for a nuclear power plant is designed in which the pumping power required for the steam circulation is considerably reduced. In the reactor, the steam is passed through successive series sections of the reactor and thereby superheated, and a plurality of de-superheaters are provided between the series sections. The condensed steam returning to the reactor is divided into a number of streams, one going to a first series section in the reactor, and the others fed to de-superheaters for mixing with the steam passing therethrough. (D.L.C.)

Production Reactors

21356 (HW-SA-2951) NPR POWER SUPPLIES. Roy C. Hoffman (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 12, 1963. Contract AT(45-1)-1350. 15p.

An effective high reliability electric power supply for the NPR Reactor Plant was provided by the use of two separate power sources. The sources are independent and the plant

components are isolated from each other. The loads were sized and divided between the two power systems. Each system has the necessary loads to safely shutdown the reactor plant after total failure of the other system and without assistance from the diesel driven "last-ditch" pumps. (auth)

Research Reactors

21357 (BLG-135) REACTEUR BR1. PREMIERE OPERATION DE RECUIT, MAI 1962. (Reactor BR1. First Operation of Annealing, May 1962). G. Penelle, et al. (Brussels. Centre d'Étude de l'Énergie Nucléaire). Oct. 1962. 221p.

The new system which was used is described, and the advantages of unloading the U are listed. The studies and simulations done before the annealing, the methods used for measuring the energy of the graphite, and an estimate of the cost of the material are discussed. Descriptions of the material, the procedures established in order to guarantee the safety of the operation, and the doses integrated by the workers during the double handling of the 28 tons of irradiated U in the core are included. A chronology of the annealing and its results are discussed and illustrated. The remaining energy in the central part of the pile, which was held at 300 to 390°C for 26 hr, was determined to be 2 cal/g down from 90 cal/g. (auth)

21358 (HW-73693) GENERAL DESCRIPTION OF THE HIGH TEMPERATURE LATTICE TEST REACTOR. D. E. Wood (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). July 19, 1962. Contract AT (45-1)-1350. 4p.

The general concept of the HTLTR is described to serve as a basis for discussion and preliminary analysis of the reactor. Items discussed include basic concept of the experimental methods, thermal requirements, access to the sides and core, power level and the initial program. (J.R.D.)

21359 (HW-76646) PRTR MECHANICAL SEAL PUMP OPERATING EXPERIENCE, AUGUST 1960 THROUGH NOVEMBER 1962. P. A. Scott (General Electric Co. Hanford Atomic Products Operation, Richland, Wash.). Mar. 1963. Contract AT(45-1)-1350. 33p.

The operation of the primary pump of the Plutonium Recycle Test Reactor (PRTR) during the two years following the initial testing period is described. The final test run of the reactor pump in the Primary Loop Mockup was discontinued after 7197 hr although the primary seal faces had not failed. The final test run of the small pump with the prototype of a self-adjusting mechanical seal assembly, interchangeable with the reactor pumps, completed 10,897 hr without primary seal failure. A total of 20 operating runs for the 4 available pump units were completed. Fifteen of these runs were terminated because of failure of the high-pressure mechanical seals after an average operating time of 1250 hr. The last completed run of each pump averaged 2050 hr with the longest period being 7 months with 4094 hr total operation. Seal life was increased from an overall average life of 1000 hr to an average life longer than 2000 hr. The final test runs indicated that operating periods of 1 to 2 yr are feasible. (M.C.G.)

21360 (NP-12702) HAZARDS SUMMARY REPORT, REVISION I. (Western New York Nuclear Research Center, Inc., Buffalo). Jan. 21, 1963. 129p.

A description of the design, location, operation, and hazards analysis of the Western New York Nuclear Research Center is presented. Results of the analysis show that the consequences of maximum credible accidents can be controlled so that personnel exposures are in the permissible range. Safe operation of the reactor under specifications included in the analysis is assured. (J.R.D.)

21361 CONSTRUCTIONAL PROBLEMS WITH AVR HIGH-TEMPERATURE REACTOR. H. Knuffer (Arbeitsgemeinschaft Versuchs-Reaktor (AVR) GmbH, Duesseldorf). Atomwirtschaft, 8: 165-70(Mar. 1963). (In German)

Various advanced reactor projects as, for example, the AVR high temperature reactor of the 15 Mw(e) experimental power station that is being erected inside the Jülich Nuclear Research Centre offer typical examples by which special construction problems and their solution can be demonstrated. As with many other concepts the basic requirement in the case of the AVR reactor is for simplicity of construction combined with very high reliability. Although this requirement is being met by the use of constructions and materials which were proved in other conventional installations a host of problems have to be solved which spring from the high requirements on operational reliability of this high temperature reactor. It should attain without difficulty a live steam state of about 500°C and 100 atm. Because of the high cooling gas temperature the customary and proven cooling means for gas cooled reactors cannot be used here and pure helium gas is to be employed. The spherical fuel elements consist of uranium carbide and graphite and, because the graphite coating of the fuel elements is permeable to some fission products, the reactor must have an overall container in the form of a reactor pressure vessel outside the individual core. The requirements and realization of the steam generator, the cooling gas circulating fans, and the by-pass system of the AVR reactor are dealt with in detail. Since the steam generator is no longer accessible after the reactor becomes operational because of radioactive contamination of the gas circulatory system the primary requirement is one of absolute operational reliability. Because, in spite of all precautionary measures during operation the possibility of damage cannot be excluded, it is necessary to be able to switch out individual damaged parts of the heating surfaces. For this reason also a certain reserve of heating surface is built in. The AVR steam generator consists in principle of four forced-circulation systems in parallel. The tubes in the horizontal planes of the steam generating assembly have an involute form. A thorough partitioning and boxing of the heating surface ensures that the superheating temperature is largely independent of the loading. The complete steam generator with a heating surface of 1,800 m^2 and a weight of about 40 t can be accommodated in a space of 3.5 m diameter and 5.5 m height. In the case of the cooling gas blowers the most stringent requirement is again one of operational reliability since the fan wheel of the blower at least turns in the radioactively contaminated gas stream. Two blowers are provided which individually can deal with 60% or in parallel 100% of the reactor loading. Because of the early state of development of gas cooled blowers the ideal could not be fitted and a special construction was adopted to ensure that the cooling gas was not contaminated by oil vapor from the lubricated bearings. The blower housing with bearings, labyrinth seals, fan wheel, electric motor, and its cooling arrangements is full gas sealed on the reactor side and can be changed as a whole by means of a special instrument. The by-pass system provides an additional safety measure in that the steam generator is protected from damage if the cooling falls off. Main and by-pass valves are situated in the radioactively contaminated circuit. A special construction is described which enables them to be turned through a

completely gas tight seal in the wall of the reactor pressure vessel. (auth)

21362 RADIOISOTOPE PRODUCTION IN THE FIRST ATOMIC REACTOR OPERATING IN PERU. Ignacio Frisancho Pineda. Bol. Inform. Junta Control Energ. At. (Peru), 7: 6p.(1962). (In Spanish)

The production of the radioisotopes P^{32}, Au^{198}, Na^{24}, and I^{131} in the South American Demonstration Reactor, installed and operated in Peru in 1961, is described. (tr-auth)

21363 DETERMINATION OF THE RELATIVE NEUTRON FLUX, IN THE FIRST NUCLEAR REACTOR OPERATING IN PERU, BY MEASUREMENT OF THE REACTION $Au^{197}(n,\gamma)Au^{198}$. Ignacio Frisancho Pineda. Bol. Inform. Junta Control Energ. At. (Peru), 7: 9p.(1962). (In Spanish)

The total neutron flux along the 5-1 and 5-2 fuel elements of the first Peruvian reactor was measured using gold foils. The procedure used is tabulated, and the measurement results are shown graphically. It was believed that the high flux measured in the 5-1 fuel element was because of its proximity to the neutron source. (J.S.R.)

21364 THE COOLING REQUIREMENTS AND PROCESS SYSTEMS OF THE SOUTH AFRICAN RESEARCH REACTOR, SAFARI 1. J. R. Colley (Atomic Energy Board, Pretoria). S. African Mech. Eng., 12: 115-25(Dec. 1962).

The SAFARI 1 research reactor is cooled and moderated by light water. There are three process systems, a primary water system which cools the reactor core and surroundings, a pool water system, and a secondary water system which removes the heat from the primary and pool systems. The cooling requirements for the reactor core and experimental facilities are outlined, and the cooling and purification functions of the three process systems are described. (auth)

21365 SUPPORTING GRID FOR THE CORE OF A SWIMMING POOL REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,236,605. June 13, 1960. Filed June 11, 1959.

A supporting grid for the core of a swimming pool reactor comprises four rectangular grid plates which are placed side by side in an overlapping manner and form a free central space of square cross section. The dimensions of this central space can be regulated by displacement of the grid plates in directions inclined at 45°C to the sides of the central free square space. Preferably the grid plates are mounted on slides which are moved by a drive system comprising screws moving female screws fixed on said slides. (IIB)

21366 SWIMMING POOL REACTOR. (to Commissariat à l'Énergie Atomique). French Patent 1,241,200. Aug. 8, 1960. Filed Aug. 3, 1959.

A swimming pool reactor comprises a pool divided into at least two chambers by one or more thresholds which are lower than the depth of the pool, one or several reactor cores each constituted of elements having identical shapes and supported by supporting grid plates mounted on the floor of the pool, these elements being fuel elements, reflector elements or tubes enclosing different devices, e.g., control rods, ionization chambers, neutron sources for starting the chain reaction, or irradiation thimbles. The reactor core is surrounded by removable autonomous casings for irradiation, while hot cells are provided disposed above the water level in the pool. These cells are in communication with lower regions of the pool via ducts having shieldings which have a downwards decreasing thickness. (IIB)

21367 SWIMMING POOL REACTOR FOR STUDYING THE INFLUENCE OF RADIATION ON MATERIALS. (to Commissariat à l'Énergie Atomique). French Patent 1,269,630. July 10, 1961. Filed May 20, 1960.

A swimming pool reactor for studying the influence of radiation on materials comprises within the reactor pool a tank for the reactor core. In order to provide for cooling of the core by forced circulation of water independent from the pool water, carriages displacable within the pool are on rails radially disposed around the reactor core, such carriage being adapted to support materials which are irradiated by conveying them into the proximity of the reactor core. Means immersed in the pool are provided for observing by X-rays the irradiated materials, while outside the tank, there are means, for shifting said carriages without breaking the mechanical and electric connections, connecting these carriages to the apparatus outside the pool. The materials to be irradiated are suitably enclosed within a loop provided with gas cooling, while means are associated to the loop for ensuring by neutron diffusion the isotropy of the neutron flux used for irradiation of said materials. (IIB)

SPACE APPLICATIONS AND TECHNOLOGY

Refer also to abstract 20174.

21368 (AD-282179) FEASIBILITY DETERMINATION OF A NUCLEAR THERMIONIC SPACE POWER PLANT. Quarterly Technical Progress Report for Period May 1, 1962 through July 31, 1962. (Aerojet-General Nucleonics, San Ramon, Calif.). Contract AF33(657)-8977. 12p. (AN-693)

Research on a thermionic radiation system is reported. In developmental work on bonding of energy converter materials to liquid metal tubing, a previously Al_2O_3–sprayed Nb tubing specimen was examined metallographically. Results showed that the coating has about 40% porosity and that the Al_2O_3–Nb bonding is good. Other samples involving plasma-sprayed Al_2O_3 on steel had about 10 to 15% porosity and good bonding. Other work is reported on preliminary design of a liquid metal loop for demonstration of thermionic converters. (J.R.D.)

21369 (NAA-SR-Memo-7573) THERMAL ANALYSIS OF R-C 13, LAUNCH PHASE. P. W. Johnson (Atomics International. Div. of North American Aviation, Inc., Canoga Park, Calif.). July 18, 1962. Contract [AT(11-1)-Gen-8]. 50p.

Aerodynamic heating of the SNAP-2 radiator-condenser is an important design consideration. Heat creating temperatures in the 550 to 900°F range will rule out many optimum weight configurations. The effects of aerodynamic heat on the temperatures of twenty-seven specific cases of an Al-steel radiator-condenser are summarized. The maximum skin temperatures and skin-tubing differential temperatures are presented to aid in the selection of an optimum design. Future design work will be assisted by the plots of "heat sink" values as a function of temperature. In the past, various radiator-condenser designers used a minimum value of 0.2 BTU/ft^2°F; the included plot indicates the validity of this assumption. Other heat sink values ranging from 0.145 to 0.267 are presented with their maximum skin temperatures at various radiator-condenser stations. (auth)

21370 (NP-12688) SUNFLOWER ROTATIONAL SPEED CONTROL TOPICAL REPORT. V. R. Lalli (TAPCO. Div. of Thompson Ramo Wooldridge, Inc., Cleveland). Mar. 1963. 68p. (ER-4947)

A rotational speed control, tailored to the Sunflower system requirements, was designed and fabricated in breadboard, preprototype, and prototype configurations. These units were subjected to performance and environmental testing which has led to design improvements. Program efforts have yielded hardware capable of meeting all performance requirements and of operating under all the environmental conditions to which the units were exposed. Attractive design changes were identified and, in some cases, completed. These changes involve improvements in circuitry and packaging, the primary objectives of which are to eliminate startup bias batteries and reduce weight. It is recommended that the reported program be extended to implement these improvements. (auth)

21371 STARTING AND CONTROL CHARACTERISTICS OF NUCLEAR ROCKET ENGINES. Willem Jansen and John K. Buchner (Northern Research and Engineering Corp., Cambridge, Mass.). AIAA (Am. Inst. Aeron. Astronaut.) J., 1: 563-73(Mar. 1963).

The problem of the starting and control of a hypothetical nuclear rocket engine with a bleed cycle arrangement is studied parametrically with the aid of an analog computer. The study includes the investigation of both the open-loop (with a programed control rod ramp) and controlled system. Starts are considered with the reactor initially subcritical and critical. The open-loop system is inherently well behaved. Temperature changes are not as severe as power variations, although permissible temperature gradients may be exceeded. The initial transients of the uncontrolled system are due mainly to the time constants associated with thermal and mechanical processes, whereas the long-term transient is the result of the neutron precursor groups with long half lives. It is possible to control the temperature and pressure satisfactorily and to meet realistic limitations on maximum design temperature and temperature rise rates. Control is accomplished by a reactor core exit pressure reference feedback control of the turbopump system flow rate and a reactor core exit gas temperature reference feedback control of the reactor power output. Controlled but rapid transitions from initial to full power are possible, and changes in thrust at design conditions are performed rapidly without excessive temperature excursions. (auth)

21372 APPLICATION OF A COMBINED OPTICAL AND R-F COMMUNICATIONS SYSTEM FOR NUCLEAR POWERED INTERPLANETARY SPACE VEHICLES. L. B. Wilker (Westinghouse Astronuclear Lab., Pittsburgh) and V. B. Morris, Jr. 1963. 21p. $1.00.

To be published in Proceedings of the Interplanetary Missions Conference Ninth Annual American Astronautical Society Meeting, Statler Hilton Hotel, Los Angeles, California, Jan. 1963.

A major evolution in space communication systems for interplanetary travel is being compelled by the development of nuclear powered space vehicles. The advent of the SNAP-50 auxiliary power plant enhances the probability of unmanned space vehicles reaching Venus and Jupiter. A space vehicle command, guidance, control, and data transmission combination must be evolved into one system due to the characteristics of mission demands. A high powered continuously operable laser oscillator with nearly-diffraction-limited beamwidths and narrow bandwidths extends the field of data transmission including television pictures of outer space. A system of this nature may be achieved through use of an orbiting data satellite network, which will allow use of optics for deep space communication and an r-f link between satellite and earth. Ordinarily communication systems are limited by the space vehicle's power, weight, and economic restrictions. In accomplishing a combination of optical and r-f links, the necessary trade-offs among the aforementioned parameters are minimized. The conceptual system described may result in the elimination of many problems encountered by direct optical links due to the effect of the earth's atmosphere, attenuation, backscatter, and random "noise." The system as outlined uses present state-of-the-art components with the exception of the optical link, since many of the components for use in an optical communication system have not reached the degree of perfection necessary for reliable use. Consideration is also noted on the effects of nuclear radiation upon system components. (auth)

WASTE DISPOSAL AND PROCESSING

Refer also to abstracts 19747 and 20244.

21373 (IDO-12027) A COMPARISON OF TWO METHODS OF SAMPLING GRAVEL FOR THE EVALUATION OF A GROUND-DISPOSAL SITE FOR RADIOACTIVE LIQUID WASTE. D. B. Hawkins and D. C. Foster (Idaho Operations Office. Health and Safety Div., AEC). Mar. 1963. 20p.

Methods of sampling Lost River alluvium are compared, and the ability of these methods to provide good estimates of the total fine-grained material in the alluvium is discussed. (J.R.D.)

21374 (ORNL-TM-549) ENGINEERING DEVELOPMENT OF NUCLEAR WASTE POT CALCINATION. M. E. Whatley, C. W. Hancher, and J. C. Suddath (Oak Ridge National Lab., Tenn.). Apr. 24, 1963. Contract W-7405-eng-26. 36p.

The pot calcination process fixes the radioactivity from nuclear waste solutions by drying and calcining in pots which can be sealed for storage. Experimental data from "cold" runs were correlated using mathematical models which will allow the prediction of plant capacity when radioactive decay heat is present. Problems in control, in the handling of concentrated waste solutions, in the specification of plant components, and in the handling and sealing of pots were studied experimentally in engineering facilities using simulated waste solutions. (auth)

21375 (ORNL-TM-568) REMOVAL OF MERCURY FROM WASTE SOLUTIONS PRIOR TO CALCINATION OR FIXATION. W. E. Clark, J. F. Easterly, and H. W. Godbee (Oak Ridge National Lab., Tenn.). Apr. 24, 1963. Contract [W-7405-eng-26]. 7p.

More than 99.9% of the mercury was removed from Hanford 1965 FTW waste by displacement with copper. The method appears to be quite feasible for all except the more concentrated of the nitrate wastes. An evaluation of the advantages and disadvantages of the method compared to the operation of a mercury trap in the calciner off-gas line is desirable. (auth)

21376 (ORO-587(Vol.II)) AN ECOLOGICAL SURVEY OF THE LIMNOLOGY OF WHITE OAK CREEK AND LAKE. (Tennessee Valley Authority, Norris, Tenn.). Feb. 1954. Contract [AT(40-1)-221]. 180p.

Radioactive wastes from the Oak Ridge National Laboratory were impounded in White Oak Lake. Results are presented from an ecological survey conducted in 1954 of White Oak Lake and Creek. (C.H.)

21377 THE PROCESSING PLANT FOR LIQUID RADIOACTIVE WASTE AT THE ISPRA CENTRO COMUNE DI RICERCHE. Guido Branca and Gunther Sternheim. Comit. Nazl. Energia Nucl., Notiziario, 9: No. 2, 29-38 (Feb. 1963). (In Italian)

The plant for the processing of radioactive liquid wastes constructed at Ispra was successfully tested in August 1962. The basic assumptions used in the selection of the process chosen and of the plant dimensions, flowsheet, process efficiency, and disposal of treated wastes at the plant are described. (J.S.R.)

21378 DISPOSAL OF FISSION PRODUCTS IN CONCRETE. E. Lazzarini (CESNEF, Milan) and G. Tognon. Energia Nucl. (Milan), 10: 117-30(Mar. 1963). (In English)

The possibility of disposing of fission products by insertion in concrete was studied. Laboratory test were performed with the aim of finding: the most suitable type of cement; the most suitable concrete composition; the effect of high concentrations of some salts normally not present in concretes on their mechanical properties and workability; leaching of fission products from cement mortars in drinking water and sea water; the effect of radiolysis on leaching; diffusion of fission products through layer of cement mortar; adsorption of fission products in cement mortar. The results obtained in these experiments ascertained that this method has good application possibilities, particularly for radioactive waste disposal from small nuclear centers where the more complex processes of fixation in glasses and ceramics would not be economically justified. (auth)

21379 WHAT CAN WE DO WITH RADIOACTIVE WASTES? James I. Stevens and J. A. McBride (Phillips Petroleum Co., Idaho Falls, Idaho). Mech. Eng., 46-50 (Dec. 1962).

Methods for the storage and disposal of radioactive wastes are reviewed. The need for ultimate disposal methods is stressed. The feasibility of disposal in oceans and in land masses is discussed. Methods for the fixation of radioactivity in stable, solid media described include pot calcination, fluid bed calcination, radiant heat spray drying, rotary ball mill calcination, adsorption on clay-type minerals, and incorporation into glasses or glass-like matrices. Cost factors for the various waste disposal methods are considered. (C.H.)

21380 HOT-CELL STUDIES ON THE SOLIDIFICATION OF HANFORD HIGH-LEVEL WASTES BY RADIANT-HEAT SPRAY AND POT CALCINATION. R. T. Alleman, R. L. Moore, F. P. Roberts, and U. L. Upon (General Electric Co., Richland, Wash.). Preprint 9. New York, American Institute of Chemical Engineers, 1963. 36p. $0.50.

The hot-cell calciner equipment, its mode of operation, and preliminary results with full-level Hanford Purex Plant waste are described. (P.C.H.)

21381 THE HANFORD PROGRAM FOR MANAGEMENT OF HIGH-LEVEL WASTE. R. E. Tomlinson (General Electric Co., Richland, Wash.). Preprint 5. New York, American Institute of Chemical Engineers, 1963. 41p. (HW-SA-2515(Rev.)). $0.50.

A program proposed to decrease the mobility of the stored materials, thereby achieving increased assurance of continued containment of the radioactive materials, is described. Large volumes of essentially non-heating dejacketing wastes would be evaporated to salt cakes in existing underground tanks. The self-heating wastes would be fractionized to permit the separate storage of the long-lived heat emitters in small-volume, high-integrity containers. These materials could be made available for beneficial use on request. After five to ten years decay of the short-lived heat emitters, the residual salt wastes would be combined with current dejacketing wastes and evaporated to salt cakes. An obsolete canyon-type building would be reactivated and revised to conduct the chemical processing operations required. Solvent extraction would probably be used to isolate Cs, Sr, and Ce from acid waste and dissolved sludges. Cesium would be removed from the stored alkaline supernatant solutions by adsorption on a zeolite. The integrated operation is anticipated to be in operation about 1966. (auth)

21382 DEVELOPMENT OF THE FLUIDIZED BED WASTE CALCINATION PROCESS. J. A. Buckham, L. T. Lakey, and J. A. McBride (Phillips Petroleum Co., Idaho

Falls, Idaho). Preprint 6. New York, American Institute of Chemical Engineers, 1963. 35p. $0.50.

A fluidized bed calcination process was developed for conversion to granular solids of aqueous wastes, particularly those from processing aluminum alloy fuels. Pilot plant scale tests with non-radioactive material were conducted in 6- and 12-in.-dia electrically heated fluidized beds and in a 24-in.-square NaK-heated bed. The studies were extended in a 48-in.-dia NaK-heated Demonstrational Waste Calcining Facility through radioactive tracer level runs preliminary to operation with full-level radioactive wastes. Capacity factors, shown to be dependent upon heat introduction rate, were correlated as were methods developed for controlling particle size, intra-particle porosity, solids carryover, and the crystalline nature of the product. Methods used to remove entrained solids from the off-gas to a level permitting disposal of the gas to the environment are discussed. Possible post-calcination treatments of the granular calcine to improve long-term storage safety are discussed. (auth)

21383 WASTE GUIDE FOR THE URANIUM MILLING INDUSTRY. E. C. Tsivoglou (Robert A. Taft Sanitary Engineering Center, Cincinnati) and R. L. O'Connell. Robert A. Taft Sanitary Eng. Center, Tech. Rept. W-62-12, 78p.(1962).

A series of in-plant surveys of U mills were undertaken for the purpose of developing detailed information regarding the characteristics of wastes resulting from the extraction of U from its ores. Although primary interest was in the radioactive wastes, especially Ra^{226}, data regarding the chemical characteristics and toxicity of the wastes were also obtained. Field studies of the fate of the wastes in the water environment and their effects on water quality were also conducted. The waste guide is a compilation of the findings of the studies. (Public Health Eng. Abstr., 43: No. 4, April 1962)

21384 PROCESS AND WASTE CHARACTERISTICS AT SELECTED URANIUM MILLS. Robert A. Taft Sanitary Eng. Center, Tech. Rept. W-62-17, 94p.(1962).

The results of detailed studies of process and waste flows at 5 typical U mills are reported. The studies were initiated in 1957 for the purpose of characterizing the liquid and solid wastes resulting from U milling processes. The extraction and recovery processes employed are determined by the character of the ore and its U content. The 5 mills reported on typify the processes normally encountered, such as, acid or alkaline leaching of the ore, concentration and purification of the leach liquor by ion exchange or solvent extraction, and chemical precipitation of the dissolved U. Although the radioactive waste materials, especially Ra^{226}, were of primary interest, useful information regarding the chemical characteristics of milling wastes was also obtained. The entire body of information thus developed forms an excellent basis upon which to characterize the waste products from the industry as a whole. (TCO)

21385 ION-EXCHANGE MINERALS AND DISPOSAL OF RADIOACTIVE WASTES—A SURVEY OF LITERATURE. B. P. Robinson. U. S. Geol. Surv., Water Supply Paper, 1616, 138p.(1962).

A comprehensive review of the literature on clay minerals and other naturally occurring silicate materials that exhibit the phenomenon of ion exchange and on their possible adaptation for use in the disposal of radioactive wastes is presented. Approximately 600 references and a subject index is provided. (TCO)

CORPORATE AUTHOR INDEX

This index contains entries for all report literature and, in addition, for certain published literature items for which it is felt that a corporate approach is especially desirable, e.g., symposia, conference proceedings, and meetings.

Each entry under a corporate author is a shortened version of the title of the publication, followed by the *NSA* volume and abstract number. Report numbers are given in parentheses.

The phrase "Progress report" is abbreviated as "Prog. rpt." This change permits a more rapid and complete alphabetical arrangement of the titles without changing the location of the progress report titles in relation to the other titles.

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Æ	becomes	ae
ö		oe
ø		oe
ü		ue (except in transliterated Chinese names)

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As an aid to the users of this index, references to report numbers, where appropriate, are included after the abstract number of the citation.

The number preceding the colon is the *NSA* volume number, and the number following is the abstract number in that volume. The designation (R) following the abstract number indicates that the abstract is of a progress report; (P) indicates a patent; and (T) indicates a translation. Abstracts for reports other than progress reports carry no letter designation. Published literature (journal article or book) is identifiable by the absence of a report number.

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IV-303-1(Rev.1)	17-21308	See ACNP-63508
IV-303-4(Rev.1)	17-21305	See ACNP-61543
IV-304(Rev.1)	17-21309	See ACNP-63511
IV-305(Rev.2)	17-21306	See ACNP-62600
IV-312	17-21320	See TID-18528
IV-314	17-21321	See TID-18529
IV-316(Rev.1)	17-21302	See ACNP-61517
IV-320(Rev.2)	17-21304	See ACNP-61534
IV-322(Rev.2)	17-21307	See ACNP-62607
IV-323(Rev.3)	17-21303	See ACNP-61529
FR–	**(Misc.)**	
4737*	17-20562	See NP-12717
4947*	17-21370	See NP-12688
EURAEC–		
439	17-20431	See ATL-A-126
481	17-20448	See ATL-A-133
555	17-20449	See ATL-A-134
578	17-20513	See GEAP-3771-7
592	17-21219	See GEAP-3843
FTD-TT–	**(Non-AEC)**	
62-269	17-20199	$26.00(OTS)
62-958	17-20597	OTS
GA–	**(Misc.)**	
2732	17-20556	Dep.(mc); $3.60(fs), $1.19(mf) OTS
3393	17-21157	Nuovo Cimento (10), 27: 1130-7(1963)
3783	17-21218	Dep.(mc); $3.60(fs), $1.40(mf) OTS
GACD–	**(Non-AEC)**	
3223	17-20511	
GAMD–	**(Misc.)**	
2970(and Add.1, 2,&3)	17-21313	Dep.(mc); $12.50(fs), $5.51(mf) OTS
GEAP–	**(Misc.)**	
3743(Pt.II)	17-20512	Dep.; $0.50(OTS)
3771-7	17-20513	Dep.(mc); $8.60(fs), $2.75(mf) OTS
3843	17-21219	Dep.(mc); $3.60(fs), $1.25(mf) OTS
3880(Pt.I)	17-20402	Dep.; $1.75(OTS)
4018	17-20956	Dep.; $0.50(OTS)
4028	17-21220	Dep.; $0.75(OTS)
4146	17-21314	Dep.; $1.75(OTS)
4159	17-21221	Dep.(mc); $7.60(fs), $2.36(mf) OTS
4162	17-21315	Dep.; $0.50(OTS)
4201	17-19928	Dep.(mc); $3.60(fs), $1.16(mf) OTS
GLR–		
11	17-20174	See TID-17707
HE–	**(Misc.)**	
150-209	17-21132	Dep.(mc); $4.60(fs), $1.70(mf) OTS
HMI-B–	**(German)**	
21	17-20240	Dep.(mc)

Report No.	Abstract No.	Availability
HW–		
69680	17-20433	Dep.; $6.60(fs), $2.06(mf) OTS
70892	17-20193	Dep.; $1.60(fs), $0.80(mf) OTS
73693	17-21358	Dep.(mc); $1.10(fs), $0.80(mf) OTS
75319	17-20825	Dep.(mc); $1.60(fs), $0.80(mf) OTS
75447	17-20098	Dep.(mc); $1.60(fs), $0.80(mf) OTS
75654	17-20455	Dep.(mc); $3.60(fs), $1.31(mf) OTS
75806	17-20981	Dep.; $2.25(OTS)
76646	17-21359	Dep.; $0.75(OTS)
76952	17-20412	Dep.; $0.50(OTS)
HW-SA–		
2515(Rev.)	17-21381	41p. of "The Hanford Program for Management of High-Level Waste." Preprint 5. New York, American Institute of Chemical Engineers, 1963. $0.50
2676	17-19796	Intern. J. Radiation Biol. 6: 173-80(1963)
2875	17-20982	Dep.(mc); $1.10(fs), $0.80(mf) OTS
2951	17-21356	Dep.(mc); $1.60(fs), $0.80(mf) OTS
IA–	**(Non-AEC)**	
755	17-20983	Dep.(mc)
756	17-19939	Dep.(mc)
799	17-19940	Dep.(mc)
IDO–		
12027	17-21373	Dep.(mc); $1.60(fs), $0.80(mf) OTS
14598	17-20514	Dep.; $0.75(OTS)
16845	17-21222	Dep.; $0.50(OTS)
16851	17-20052	Dep.; $0.50(OTS)
28597	17-21316	Dep.; $1.50(OTS)
IPPJ–	**(Japanese)**	
4	17-21133	Dep.(mc)
5	17-20557	Dep.(mc)
IS–		
517	17-19990	Dep.(mc); $2.60(fs), $0.86(mf) OTS
586	17-20018	J. Am. Chem. Soc. 85: 481(1963)
600	17-20724	Phys. Letters, 4: 140-2(1963)
ISS–	**(Italian)**	
63/10	17-20306	Dep.(mc)
63/11	17-20829	Dep.(mc)
63/12	17-20830	Dep.(mc)
63/13	17-20831	Dep.(mc)
63/14	17-20832	Dep.(mc)
63/15	17-20833	Dep.(mc)
63/16	17-20834	Dep.(mc)
63/17	17-20835	Dep.(mc)
63/18	17-20836	Dep.(mc)
63/19	17-20307	Dep.(mc)
63/26	17-20347	Dep.(mc)
JINR–	**(Russian)**	
D-1202	17-20837	Dep.(mc)
E-1170	17-20838	Dep.(mc)
E-1189	17-20839	Dep.(mc)
E-1194	17-20840	Dep.(mc)
E-1208	17-20841	Dep.(mc)
P-1168	17-20842	Dep.(mc)
P-1178	17-20984	Dep.(mc)
P-1179	17-20843	Dep.(mc)
P-1187	17-20985	Dep.(mc)
P-1188	17-20844	Dep.(mc)
P-1195	17-20845	Dep.(mc)
P-1197	17-20986	Dep.(mc)
P-1206	17-20846	Dep.(mc)
P-1207	17-20847	Dep.(mc)
JPL-TR–	**(Non-AEC)**	
32-373	17-20848	$3.60(fs), $1.19(mf) OTS
JPRS–	**(Non-AEC)**	
17530	17-20280	$1.00(OTS)
18605	17-20803	$0.50(OTS)
18633	17-19753	$0.50(OTS)
JüL–	**(German)**	
90-ST	17-20348	Dep.(mc)
101-PP	17-20392	Dep.(mc)
KAPL–		
2217	17-21317	Dep.; $2.00(OTS)
LA–		
2805	17-20987	Dep.; $2.50(OTS)
2808	17-20194	Dep.; $1.60(fs), $0.80(mf) OTS
2834	17-20957	Dep.; $1.25(OTS)
2837	17-20393	Dep.; $2.50(OTS)
LADC–		
4844	17-20171	Dep.(mc); $4.60(fs), $1.70(mf) OTS
5510	17-21161	Phys. Fluids, 6: 501-7(1963)
5687	17-21056	Phys. Letters, 4: 153-5(1963)
LAMS–		
2873	17-20958	Dep.; $0.75(OTS)
MATT–		
143	17-21134	Dep.(mc); $3.60(fs), $1.34(mf) OTS
147	17-21163	Phys. Fluids, 6: 592-3(1963)
164	17-21135	Dep.; $0.50(OTS)
168	17-21136	Dep.(mc); $2.60(fs), $1.07(mf) OTS
MITNE–	**(Misc.)**	
30	17-20099	Dep.(mc); $9.60(fs), $3.68(mf) OTS
MR-N–	**(Non-AEC)**	
297	17-21201	See NARF-62-13T
MURA–	**(Misc.)**	
661	17-21107	Dep.; $1.25(OTS)
NAA-SR–		
8140	17-21223	Dep.; $2.25(OTS)
NAA-SR-Memo–		
3518	17-20413	Dep.(mc); $1.10(fs), $0.80(mf) OTS
3556 and Add.	17-21318	Dep.(mc); $4.60(fs), $1.64(mf) OTS
4365	17-20349	Dep.(mc); $1.10(fs), $0.80(mf) OTS
6836	17-20403	Dep.(mc); $1.60(fs), $0.80(mf) OTS
7573	17-21369	Dep.(mc); $4.60(fs), $1.70(mf) OTS
NARF–	**(Non-AEC)**	
62-13T	17-21201	
NASA-TT–	**(Non-AEC)**	
F-124	17-20812	347p. of "Physical Processes in Stellar Interiors." (Fizicheskie Protsessy Vnutri Zvezd). Translated from Russian, 1962
NBL–		
191	17-20308	Dep.; $0.75(OTS)
NBS–	**(Misc.)**	
7677	17-21137	Dep.(mc); $1.10(fs), $0.80(mf) OTS
NBS-TN–	**(Non-AEC)**	
74	17-20849	$0.75(OTS)

Report No.	Abstract No.	Availability
NLCO–		
863	17-20434	Dep.; $1.75(OTS)
NOLTR–	**(Non-AEC)**	
62-45	17-20126	$8.10(OTS)
NP–	**(AEC File No. for Non-AEC Reports)**	
12029	17-20426	Trans. AIME 227: 36-47(1963)
12154(Rev.)	17-21138	
12678	17-20195	Dep.(mc)
12679	17-20279	
12680	17-19991	
12682	17-20404	
12688	17-21370	
12689	17-19992	
12691	17-19805	Dep.(mc)
12692	17-20241	
12695	17-20558	
12696	17-20559	
12698	17-20560	
12699	17-20172	
12700	17-20196	
12702	17-21360	Dep.(mc); $10.10(fs), $4.07(mf) OTS
12710	17-20405	
12712	17-21139	Dep.(mc)
12715	17-20561	
12716	17-19728	Dep.(mc)
12717	17-20562	
NSS–		
112	17-21319	See TID-18467
NYO–		
9437	17-20456	$3.60(fs), $1.28(mf) OTS
9438	17-20457	$1.60(fs), $0.80(mf) OTS
9534	17-20242	Dep.(mc); $5.60(fs), $2.00(mf) OTS
10062	17-20563	Dep.(mc); $8.10(fs), $2.87(mf) OTS
10173	17-20988	Dep.(mc); $2.60(fs), $0.92(mf) OTS
10478	17-21224	Dep.(mc); $1.60(fs), $0.80(mf) OTS
ORA–	**(Misc.)**	
04526-5-P*	17-20147	See AD-282370
04526-14-P*	17-20172	See NP-12699
ORNL–		
3161	17-21140	Dep.; $0.75(OTS)
3423	17-20394	Dep.; $1.75(OTS)
ORNL-TM–		
407	17-20243	Dep.(mc); $4.60(fs), $1.52(mf) OTS
412	17-20100	Dep.(mc); $6.60(fs), $2.12(mf) OTS
523	17-19941	Dep.(mc); $4.60(fs), $1.43(mf) OTS
528	17-20414	Dep.(mc); $2.60(fs), $0.92(mf) OTS
543	17-20101	Dep.(mc); $2.60(fs), $1.01(mf) OTS
549	17-21374	Dep.(mc); $3.60(fs), $1.28(mf) OTS
563	17-20102	Dep.(mc); $4.60(fs), $1.52(mf) OTS
568	17-21375	Dep.(mc); $1.10(fs), $0.80(mf) OTS
ORO–		
490	17-20350	Dep.; $0.50(OTS)
587(Vol.II)	17-21376	Dep.; $2.75(OTS)
OTS–	**(Misc.)**	
61-11437	17-20789	476p. of "Optical Transition Probabilities." $4.75(OTS)
63-20178*	17-20280	See JPRS-17530
63-21534*	17-20803	See JPRS-18605
63-21551*	17-19753	See JPRS-18633
PATENTS	**(British)**	**3s. 6d. each, U. K. Patent Office**
920,454	17-20440	
921,804	17-20093	
921,884	17-20135	
921,905	17-20300	
922,041	17-21271	
922,068	17-20136	
922,221	17-21348	
922,222	17-21272	
922,324	17-21349	
922,339	17-20190	
922,435	17-20380	
922,498	17-21273	
922,523	17-20124	
922,531	17-20301	
922,572	17-21274	
922,707	17-20428	
922,717	17-20381	
922,895	17-20382	
922,968	17-20137	
923,016	17-21198	
923,083	17-21275	
923,154	17-20094	
923,212	17-20441	
923,258	17-21276	
923,332	17-20800	
923,343	17-21277	
923,356	17-21350	
923,504	17-20138	
923,509	17-20188	
923,630	17-20337	
923,633	17-21278	
923,672	17-20442	
923,675	17-20443	
923,799	17-21279	
923,815	17-20139	
923,816	17-20140	
923,817	17-20141	
923,818	17-20142	
923,826	17-21280	
923,851	17-20302	
923,852	17-20390	
923,894	17-21351	
923,905	17-21281	
923,921	17-21282	
923,950	17-21283	
923,989	17-20338	
924,013	17-20277	
924,045	17-21284	
PATENTS	**(Czech.)**	
98,898	17-20143	
99,196	17-21200	
PATENTS	**(French)**	
1,185,212	17-21285	
1,228,525	17-21286	
1,234,694	17-21287	
1,236,605	17-21365	
1,241,200	17-21366	
1,251,623	17-21288	
1,254,826	17-21289	
1,266,508	17-21290	
1,269,630	17-21367	
1,270,554	17-21291	
1,273,173	17-21292	
1,273,232	17-21293	
1,276,293	17-20144	
PATENTS	**(U. S.)**	**$0.25 each, U. S. Patent Office**
3,082,821	17-20145	
3,084,281	17-20801	
3,084,373	17-20146	

Report No.	Abstract No.	Availability
3,085,056	17-21352	
3,085,057	17-20303	
3,085,058	17-21199	
3,085,059	17-21294	
3,085,060	17-21295	
3,085,141	17-20444	
3,085,155	17-20383	
3,085,156	17-20384	
3,085,157	17-20278	
3,085,852	17-20391	
3,085,871	17-20408	
3,085,872	17-20409	
3,085,873	17-20410	
3,085,952	17-20095	
3,085,954	17-20445	
3,085,957	17-21296	
3,085,958	17-21297	
3,085,959	17-21353	
3,085,960	17-21298	
3,085,961	17-21354	
3,085,962	17-21299	
3,085,963	17-21300	
3,085,964	17-21355	
3,085,966	17-21301	
3,086,110	17-20339	
3,086,111	17-20340	
3,086,112	17-20341	
3,086,114	17-20342	
3,086,116	17-20385	
3,086,117	17-20386	
PB–	**(Non-AEC)**	
161575	17-20849	See NBS-TN-74
PG-REPORT–	**(British)**	
157	17-19942	Dep.; $0.42(BIS); 3s. (HMSO)
PNE–		
204F	17-19729	Dep.; $0.50(OTS)
205F	17-19730	Dep.; $0.50(OTS)
226(P)	17-19750	Dep.; $0.75(OTS)
233F	17-19731	Dep.; $0.50(OTS)
PST-Cat.–	**(Misc.)**	
501	17-20789	See OTS-61-11437
815	17-20812	See NASA-TT-F-124
PWAC–	**(Misc.)**	
213	17-20173	Dep.(mc); $4.60(fs), $1.58(mf) OTS
REIC–	**(Non-AEC)**	
26	17-20515	
SCR–		
501	17-20395	Dep.; $3.00(OTS)
578	17-20324	J. Appl. Phys. 34: 228-30(1963)
586	17-20639	Ann. Phys. 21: 122-42(1963)
SLAC–		
5	17-21108	Dep.; $3.00(OTS)
STI-DOC–	**(International Atomic Energy Agency)**	
10/13	17-20336	31p. of "Nuclear Electronic Instruments in Tropical Countries." Technical Reports Series No. 13. Vienna, IAEA, 1963
11(Vol.2)	17-19741	Dep.; IAEA
STI-PUB–	**(International Atomic Energy Agency)**	
62(Vol.II)	17-20967	
TDR–	**(Non-AEC)**	
69(2240-51)TN-1	17-20056	See DCAS-TDR-62-140
69(2703-01)TR-1	17-20554	See DCAS-TDR-62-121
TEI–		
819	17-20226	Geological Survey Bulletin 1144-C (Geological Survey, Washington, D. C.) 1963.
830	17-20406	Dep.(mc); $3.60(fs), $1.37(mf) OTS
TID–		
4025(Rev.1)(Pt.I) (Suppl.1)	17-19734	Dep.; $4.00(OTS)
7658	17-21225	Dep.; $3.00(OTS)
16046	17-19782	Proc. Natl. Acad. Sci. U. S. 48: 1373-5 (1962)
16214	17-20398	Trans. Am. Math. Soc. 106: 254-8(1963)
16247	17-20503	Z. Elektrochem. 66: 629-35(1962)
16261	17-20886	Nuovo Cimento (10), 27: 1262-5(1963)
16413	17-20458	Dep.(mc); $1.10(fs), $0.80(mf) OTS
16895	17-20415	Dep.(mc); $1.60(fs), $0.80(mf) OTS
17005	17-21259	Dep.(mc); $4.60(fs), $1.61(mf) OTS
17449	17-19767	J. Biol. Chem. 238: 1193-5(1963)
17707	17-20174	Dep.(mc); $4.60(fs), $1.46(mf) OTS
17849	17-20771	Rev. Sci. Instr. 34: 443-4(1963)
18004	17-19789	Dep.(mc); $9.60(fs), $3.80(mf) OTS
18087	17-21060	Phys. Letters, 4: 205-8(1963)
18192	17-20020	J. Am. Chem. Soc. 85: 1210-11(1963)
18271	17-20309	Dep.(mc); $3.60(fs), $1.40(mf) OTS
18363	17-21048	Phys. Letters, 4: 104-5(1963)
18411	17-19943	$1.60(fs), $0.80(mf) OTS
18422	17-19790	Dep.(mc); $6.60(fs), $2.30(mf) OTS
18431	17-20244	Dep.(mc); $2.60(fs), $0.95(mf) OTS
18442	17-20564	Dep.(mc); $2.60(fs), $0.95(mf) OTS
18456	17-20197	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18458	17-19732	Dep.(mc); $4.60(fs), $1.58(mf) OTS
18460	17-19993	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18467	17-21319	Dep.(mc); $5.60(fs), $1.88(mf) OTS
18468	17-19742	Dep.; $2.50(GPO)
18480	17-20459	Dep.(mc); $2.60(fs), $0.92(mf) OTS
18485	17-20310	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18499	17-19791	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18500	17-20057	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18502	17-20198	Dep.(mc); $3.60(fs), $1.40(mf) OTS
18503	17-21141	Dep.(mc); $1.10(fs), $0.80(mf) OTS
18505	17-20989	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18506	17-20990	Dep.(mc); $2.60(fs), $0.89(mf) OTS
18507	17-20991	Dep.(mc); $2.60(fs), $0.83(mf) OTS
18508	17-20992	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18510	17-19806	Dep.(mc); $1.60(fs), $0.80(mf) OTS
18528	17-21320	Dep.(mc); $6.60(fs), $2.06(mf) OTS
18529	17-21321	Dep.(mc); $4.60(fs), $1.56(mf) OTS
TM–	**(Misc.)**	
62-8-16	17-20459	Superseded by TID-18480
62-10-15	17-20459	See TID-18480
TO-B–	**(Non-AEC)**	
62-58	17-20245	$2.50(OTS)
TRG-Inf.–	**(British)**	
Ser.-18	17-20127	Dep.; $1.10(fs), $0.80(mf) JCL
TRG-Report–	**(Non-AEC)**	
469	17-20311	Dep.; $0.63(BIS); 4s. 6d. (HMSO)
TRICO–	**(Congo)**	
62/03	17-19733	Dep.(mc)
UAC–		
6454	17-20886	See TID-16261
6650	17-20023	See ANL-FGF-363

Report No.	Abstract No.	Availability
6956	17-20416	See ANL-FGF-358
7078	17-20771	See TID-17849
7240	17-21048	See TID-18363
UCRL–		
6631	17-21142	Dep.(mc); $4.60(fs), $1.43(mf) OTS
6915	17-20715	Phys. Fluids, 6: 579-86(1963)
6935	17-19978	Norelco Reptr. 10: 19-29(1963)
7061	17-20993	Dep.; $0.50(OTS)
7160	17-19929	Dep.; $4.00(OTS)
7165	17-19944	Dep.; $0.50(OTS)
7184	17-20460	Dep.; $0.75(OTS)
7233	17-20994	Dep.(mc); $2.60(fs), $0.86(mf) OTS
7234	17-21054	Phys. Letters, 4: 146-7(1963)
7262	17-20826	Dep.; $0.50(OTS)
7280	17-20995	Dep.; $0.50(OTS)
9652	17-19758	Arch. Biochem. Biophys. 100: 178-84(1963)
9898	17-20996	Dep.; $2.50(OTS)
10022	17-20565	Dep.; $3.50(OTS)
10572	17-20594	Dep.; $2.50(OTS)
10609	17-20997	Dep.; $2.00(OTS)
10614	17-21260	Dep.; $3.00(OTS)
10631	17-20312	Dep.; $1.25(OTS)
10640	17-19751	Dep.; $2.00(OTS)
10649	17-20998	Dep.; $2.00(OTS)
13079	17-21132	See HE-150-209

Report No.	Abstract No.	Availability
UCRL-Trans–		
934(L)	17-19735	Dep.(mc); $1.60(fs), $0.80(mf) JCL or OTS
936(L)	17-20128	Dep.(mc); $1.10(fs), $0.80(mf) JCL or OTS
UNC–	**(Misc.)**	
5043*	17-20959	
USNRDL-TR–	**(Non-AEC)**	
609	17-20246	$2.60(OTS)
612	17-20595	
620	17-19807	
622	17-19808	$1.60(OTS)
624	17-19809	
625	17-19810	$1.60(OTS)
627	17-19811	
630	17-19812	
WAPD-PWR–		
TE-148(Rev.)	17-21261	Dep.(mc); $1.60(fs), $0.80(mf) OTS
WAPD-T–		
1496	17-21322	Dep.(mc); $2.60(fs), $0.83(mf) OTS
1524	17-20961	Nucl. Sci. Eng. 15: 1p. (1963)
YAEC–		
182(Pt.II)	17-20516	Dep.(mc); $7.60(fs), $2.48(mf) OTS